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A CLINICAL SYSTEM OF TUBERCULOSIS

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DESCRIBING ALL FORMS OF THE DISEASE

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Translated from the Second German Edition

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NEW YORK
WILLIAM WOOD AND COMPANY

MDCCCCXIII

on Medical School

PRINTED IN GREAT BRITAIN

RC311
913B

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TRANSLATOR'S PREFACE.

THERE are various distinct advantages in the method adopted by Drs. Bandelier and Roepke of considering all forms of tuberculosis together in one volume. The distinction formerly drawn between "medical" and "surgical" forms of the disease is steadily becoming obscured; specific treatment, various forms of rays, and other conservative measures are being increasingly used for tubercular glands, bones, and joints, while many forms of abdominal tuberculosis are now frequently submitted to operation, and active measures, designed to produce compression, are being taken even against phthisis. Many of the modern biological methods of diagnosis are the same, too, in all forms of the disease. Some forms of tuberculosis can be better studied in one organ, some in another. The action of tuberculin on tubercular tissue can be more easily and directly observed in the eye than in an internal organ like the lungs; just as many of the changes produced by inflammation were worked out in the eye, the results thus obtained being afterwards applied to the more inaccessible organs.

This consideration of tuberculosis as a pathological entity is certainly logical; that it also meets the requirements of the practitioner is shown by the fact that a new edition of the German work was called for in a little more than a year.

In the belief that it should be equally useful to the English-speaking medical public the whole work has been translated, with the exception of parts of certain sections dealing with German sanatoriums, health resorts, and colonies, and the legal regulations in connection with public health and the German Insurance Act; also certain directions as to the technique of animal experiments have been abbreviated.

Wherever desirable the metric system has been converted into the English, and the Centigrade scale into Fahrenheit. The doses of tuberculin in the original were given in fractions of the cubic centimetre; these have been changed to the cubic millimetre,

as being both more convenient and more in accord with several recent English works.

Although in the text some references are made to English and French workers, it will be found that the authorities mentioned at the end of the book are almost entirely German. No attempt has been made to alter or add to this list; as it is felt that this deficiency is of less importance in the English translation than in the original, English readers being able to supply many of the omissions themselves.

Drs. Bandelier and Roepke are already known to many English-speaking practitioners, since a second edition of the English translation of their work on "Tuberculin in Diagnosis and Treatment" is about to appear.

I am indebted to Dr. Morland, of Arosa, for help with the chapter on pulmonary tuberculosis.

For the few foot-notes which have been added, I am solely responsible.

THE TRANSLATOR.

AUTHORS' PREFACE TO THE SECOND EDITION.

WITNES a medical work of the size of our "*Die Klinik der Tuberkulose*" requires a second edition after one and a half years, it proves that a book treating of all forms of tuberculosis has become a necessity for the medical profession, and also shows the opinion that is held of it as a scientific work.

The present second edition has not been altered either in form or in purpose. It has been our chief aim to give in due order, and as shortly as possible, a full and complete clinical description of every form of tubercular disease, so that specialists and hospital physicians, but, above all, general practitioners and students, may be able to find in one work information concerning tuberculosis on its anatomical, clinical, diagnostic, prognostic, therapeutic, and prophylactic sides.

The alterations and additions in this present issue have been chiefly designed to give the latest discoveries and the most recent views in all the chapters of the book. Therefore no chapter has remained entirely unaltered; several, as those on tuberculosis of the upper air passages, the blood and lymphatic systems, the digestive organs, the skin and the nervous systems have been completely reconstructed, as has also that on the disease in childhood; the sections on the climatic and surgical treatment of pulmonary tuberculosis, and those on tuberculosis of the kidney, the bladder, the tonsil, the throat, and the larynx have been considerably increased. New schematic charts for recording the condition of the lungs and new temperature charts have been added. Further remarks have been made on the ways and means of introducing a general system of treatment founded on the new laws of State insurance; and sections on tuberculosis of the gall-bladder, on Hodgkin's disease, on the tubercular psychoses and mental states, &c., make their first appearance.

We have also introduced, according to desire, plans from Robert Koch's immortal work on "*The Etiology of Tuberculosis*," on the bacteriological diagnosis, and on the pathological anatomy of tuberculosis of the lungs and larynx. On the other hand, we have not considered it necessary to include pictures of

reclining couches, of spittoons, of instruments, or of invalid furniture. In view of the essentially practical aim of this work we have purposely limited the allusions to the literature of the subject, but we have made the index of references more convenient by dividing it into chapters.

The first edition of this book has been very favourably received, having been praised by the responsible medical press both in Germany and other countries. We wish to thank all our critics and reviewers, especially those who have called our attention to deficiencies, or who have expressed wishes for alterations. We have examined all suggestions, and have introduced them into this second edition, whenever they appeared to us to be improvements.

By this means the second edition has been increased by more than 160 pages, apart from figures and plates. The publishers have not raised the price substantially, in spite of these additions, and in spite of the excellent way in which they have produced the work, for which we are thankful to them.

A Spanish edition of "*Die Klinik der Tuberkulose*" has already appeared; an English one will soon follow.

Our wish is that this book may henceforth play a part in stimulating interest in the clinical and practical recognition and treatment of tuberculosis in all its forms as a disease of the people. With this hope we offer our work to the public.

THE AUTHORS.

*Melangen und Schönberg,
May, 1912.*

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CHAPTER I.

Ætiology of Tuberculosis.

I. HISTORY OF TUBERCULOSIS.

TUBERCULOSIS, in its chronic pulmonary form, was even in antiquity a well-known and probably a widely-spread disease. To the clear picture drawn by Hippocrates (B.C. 400) only slight touches were added by Celsus, Aretæus and Galen. We find no further progress in the knowledge of the nature of the disease till the seventeenth century. Sylvius was the first to bring out the relationship between the nodules in the lungs and phthisis; he considered them as enlarged lymphatic glands, a view rejected by Morgagni and Baillie. Bayle recognized in miliary tubercle, as it was afterwards called by him, the anatomical basis of tuberculosis as a general disease. From Bayle's various forms of pulmonary tuberculosis Laennec separated gangrene of lung, cancer, &c., as not being tubercular processes, and so proclaimed the unity of the disease. The conception of tubercle as a new formation held its ground against the views of Broussais and Andral, who believed it to be a product of inflammation. Virchow separated caseous pneumonia from the processes characterized by tubercle formation, and so started the theory of duality, which was brought to an end by Robert Koch's discovery of the tubercle bacillus in 1882.

The idea of the infectious nature of phthisis took root early. It is of interest that the bearers of two well-known names, Valsalva and Morgagni, were afraid to dissect phthisical corpses. Laennec considered himself infected through a wound received in making an autopsy on a case of phthisis. The conviction of the contagiousness of consumption, and the intention to prevent its spread, are expressed, for example, in the regulation made in Italy at the end of the eighteenth century, that clothes and bedding used by consumptives on their death must be burnt. The first to produce artificial tuberculosis by inoculation on a rabbit

was Klencke. Villemin showed the infection of tuberculosis by further important animal experiments, using tubercles, caseous tubercular tissue and sputum, and also material from a tubercular cow. He did not obtain, however, general acceptance for his views. It remained for Robert Koch to show that in all tubercular tissue and material, and only in them, there was a characteristic little rod, which could be grown on artificial media in pure culture; the inoculation of this culture on animals producing typical tuberculosis, in which the same organism was to be found. By this discovery of the tubercle bacillus the question of the aetiology of tuberculosis was solved.

2. THE TUBERCLE BACILLUS.

The tubercle bacillus is a straight or slightly curved little rod, whose length on an average is about half the diameter of a red blood-corpuscle. It has no power of movement. In its growth it is unusually polymorphic, forming short or long rods, strings, chains, clubs and branched forms. The bacilli lie singly or in groups or clumps, sometimes they are arranged in plaits. In a hanging drop they show strongly refractive granules. On staining they are often seen to contain clear spaces at regular distances; these were at first thought to be spores; now they are generally considered to be vacuoles. The bacilli have, according to the now generally accepted view, a fatty or waxy envelope, which gives them their specific staining properties, and also accounts for the unstained spores. It is to this envelope also that the bacilli owe their powers of resistance to such external influences as cold, dryness, putrefaction and chemical agents. The bacillus dies on being heated to about 80° C. It is, however, very sensitive to light; it is killed by exposure to direct sunlight for a few minutes, or to diffuse daylight for a few days. It cannot multiply outside the human or animal body, being thus an obligatory parasite. In artificial media it grows only in the presence of oxygen and at the temperature of the body.

The bacilli treated with alcohol and ether are dissolved into free fatty acids, neutral fats and wax; further into albumens, carbohydrates, and mineral constituents (Asche). According to Deycke, it is the neutral fats which really confer the great resisting powers on the tubercle bacilli, while their special staining reaction is bound up in fatty acids, for the neutral fats are in their pure state absolutely unstainable.

The specific staining reaction of tubercle bacilli is that the colour is fast to both acids and alcohol. The usual staining

methods are those of Ziehl-Neelsen and Galtier; they leave the tubercle bacilli stained red on a blue ground. Recently Much has discovered in tubercular and lupoid tissue, as also in tubercular products, a rod-shaped, beaded organism, which he takes to be a growing or persisting form of tubercle bacillus; this he has named the Granula. They are not stained by the above-mentioned methods, but only by Gram's process.

Much, Deycke, and others have also found the granules where tubercle bacilli cannot be discovered; Deycke especially in bovine, bone and joint tuberculosis; Krüger and Much also in lupus tissue. It is still undecided whether they are to be considered as a special growing or resting form of tubercle bacillus, or whether they are rather a degenerate form. Deycke and Much put forward the view that the granules are the primitive original form, from which the acid-fast tubercle bacillus has developed phylogenetically; and that under the influence of bacteriolytic forces the acid-fast bacilli revert to the primitive and resisting forms (granula). According to Much they consist, probably, chiefly of nuclein. From their resistance to the action of antiformin he concludes that they also contain fat. As they have lost the Ziehl staining reaction, it is known that they do not contain fatty acids. According to the researches of Deycke, their power of resistance is only dependent on the presence of neutral fats.

Further investigation is required into the prognostic significance of Much's granules in tuberculosis. According to our observations up till now, cases with Much's granules in the sputum have a favourable prognosis. As regards diagnosis, our examination has shown that granules can frequently be detected in the sputum when Ziehl staining bacilli cannot be found. We must, however, take care only to reckon those structures as granules which by their shape and arrangement can be recognized as bacilli in groups.

According to the latest observations of Bittroff and Memose in the Heidelberg Institute of Hygiene no other forms of the tubercle bacillus can be shown by Much's method than by Ziehl's.

The very various material examined was obtained from the different forms of human tuberculosis, and from tuberculosis of cattle, swine, birds, rabbits, and guinea-pigs, and also from a large number of pure cultures of different ages, both human and bovine. In every preparation it was found that the tubercle bacilli, which stained with Much's method, were also acid-fast when stained by Ziehl. Also, the cases negative to Ziehl's method never gave a positive result to Much's. In several cases the granules recognized by Much's method with Ziehl's appeared as short, acid-fast rods. If the tubercle bacilli by the action of various chemical agents were deprived of their property of being acid-fast, then also in the preparations by Much's method the granules in the bacilli disappeared. Not

an organism could the disappearance of the acid-fast component of the tubercle bacillus with the persistence of the Gram-positive albuminous ground substance of Much be obtained. The authors mention the necessity of prolonged staining for twenty-four hours in Ziehl's method for such researches.

The human tubercle bacillus is under suitable experimental conditions transferable to all warm-blooded animals, and evokes a similar disease to human tuberculosis. But it is probable that each animal species has its own special producer of tuberculosis, all of which exhibit great biological resemblance. The bacilli of tuberculosis in the cold-blooded animals are also closely related to the other forms. In the same species may be included also the similar forms of pseudo tubercle bacilli found in men, animals, and plants, which share with the tubercle bacilli the property of not being decolorized by acids, and which are therefore known as acid-fast: such as the Timothy bacillus, grass-bacillus H. dung, milk, butter, leprosy, smegma and pseudo bovine tuberculosis bacilli.

It is now well established by experiment that, contrary to the older view, tubercle bacilli are met in varying strains with regard to their virulence; this fact is of importance in connection with the progress of infection in the human body.

Many of the general symptoms of tuberculosis are ascribed to the absorption of toxic products of the tubercle bacilli. We are concerned here partly with the secretion products of living bacilli, which are true toxins but with a difference; and partly with the endotoxins, which are set free by the death and breaking up of cell bodies.

3. HISTOLOGY OF TUBERCLES.

The regular local tissue changes produced by living tubercle bacilli are on the one hand the result of the mechanical irritation of foreign bodies, causing a useful proliferation having a reparative character; on the other hand the products of disintegration and the endotoxins evoke an inflammatory exudation. The tissue reactions vary according to whether one or the other process predominates.

The entering bacilli multiply, stimulate their surroundings to an exuberant growth, and cause a new formation of epithelioid cells, chiefly produced from connective tissue cells. In these central epithelioid cells, thus produced, a plentiful appearance of karyokinetic figures can be observed after seven days. This proliferation affects not only the connective tissue, but also the epithelial and endothelial cells of the vessels, and causes by

repetition of the cell division a great piling-up of epithelioid cells. Between these are found small round cells with strongly staining nuclei, which are wandering leucocytes, mobile cells that play the chief rôle in the transport of tubercle bacilli. From the great enlargement of single epithelioid cells and nuclear multiplication are formed the giant cells, well known cells that often contain tubercle bacilli. Between the nuclei and the bacilli there exists a kind of antagonism; so that if the nuclei are found at one pole, the bacilli will be at the other. By the production of new cells the stroma of the original connective tissue is pushed apart and opened out, and so gives rise to the reticulum of the tubercle. The cell proliferation exercises a pressure on the peripheral layers, and so causes a dense heaping-up and flattening of these cells, leading to an encapsulation of the tubercle. The included vessels are destroyed by coagulation.

The now completed tubercle forms macroscopically a little, grey, transparent granule, of the size of a millet seed (miliary). The further ultimate fate consists in caseous or fibrous changes. In the centre begins a gradual death of the cells, first of the leucocytic elements, then of the epithelioid cells; the nuclei disintegrate and lose their staining properties. There is now a uniform mass of debris enclosing fat globules—caseation. Macroscopically the tubercle takes on a yellow colour. With or without the co-operation of other bacteria suppuration or softening follows.

The process of healing of tubercle comes about in the following manner. The epithelioid cells exhibit prolongations and lengthen into spindle-shaped fibroblasts. Next a network of fibres is built up that gradually penetrates the whole tubercle, and converts it into fibrous tissue. This is healing by fibrous transformation. But it may happen that the caseous contents remain encapsuled in the connective tissue, and will be absorbed or calcified. The histological changes of tubercle are largely the same in the tissues of different organs.

4. PATHS OF INFECTION.

While in most infectious diseases only certain organs are attacked, in tuberculosis any organ may be the seat of the disease. The question therefore arises which are the favourite paths of entry of the tubercle bacillus, and which are the most frequent and important sources of infection in human tuberculosis? As the lungs and their lymphatics are the seats of predilection for tubercle, they are to be chiefly considered in discussing this question.

The skin need hardly be considered as a portal for the entry of the tubercle bacillus; for in an intact state it is not permeable, and so offers no favourable ground for its development. Therefore an entry can only be made through the mucous membrane lining the interior of the body. In fact, this passage through the mucous membrane is met with frequently, leading to the lodgment of the bacilli in the individual organs.

In childhood the lymphatic glands are extremely sensitive to tuberculosis—in the form of scrofula. The glandular tuberculosis of childhood can be best explained by the entry of bacilli through small superficial lesions, especially of the mucous membrane of the nose, throat, mouth, or bronchi, probably aided by the predisposing influence of a catarrh. They usually produce no changes at the point of entrance, but pass on to the neighbouring glands, where they may remain latent for some time.

The principal gates of entry into the human body are the air passages and the gastro-intestinal tract; therefore the aerogenous and the enterogenous infections can be distinguished.

Infection through the Air Passages. In pulmonary tuberculosis the chief rôle is naturally played by aerogenous infection. According to present views the tubercle bacilli can enter the lung either by the air passages or by means of the lymphatics and blood-vessels. The supporters of the inhalation theory rely on the special frequency of localization of the disease in the lungs, more especially so at its first onset, and indeed to a less degree in advanced stages; on the analogous condition of pulmonary anthracosis, which without doubt is due to inhalation; and on accurate inhalation experiments on animals by the insufflation of only a small number of bacilli, corresponding to the conditions obtaining in human infections. The views of Cornet and Flügge are in direct opposition, whether the more important part is played by infection from dry, pulverized sputum, or by droplets sprayed out during coughing, speaking or sneezing. It would take us too far to sift the statements for and against both views. The comprehensive and exact labours of both camps have shown that both kinds of infection are possible, and must be reckoned with in devising prophylactic measures.

Infection through the Blood. The hæmatogenous origin of tuberculosis is many-sided; and the different explanatory theories of pulmonary infection through the blood are very complicated. In this mode of infection the tubercle bacilli entering the body at any point (no matter whether by the skin or the mucous membrane of the nose, throat, mouth, digestive organs, or uino-generative system) are carried by the lymphatics



Fig. 1. Miliary tubercles of the lung.



Fig. 2. Giant cells with tubercle bacilli and pigment granules.



Fig. 3. Conglomerated epithelioid cells with centrally situated giant cells.



Fig. 4. Tubercle bacilli between cell nuclei.

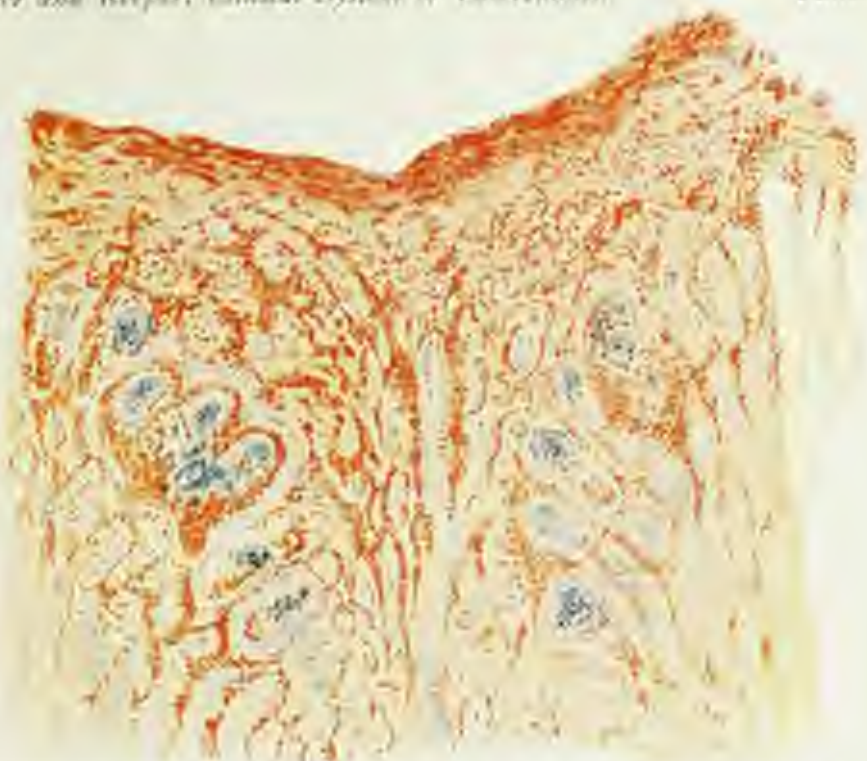


Fig. 1. Section from a pathological lung showing the advance of the tubercle bacilli into the alveoli.



Fig. 2. Part of the internal wall of a large cavity. On the right the free border of the cavity. On the left the collapsed alveolar tissue.

and blood-vessels to the lungs, which by this theory are accorded a peculiar local disposition to the disease. But opinions here diverge as to which point of entry the bacilli choose. Ribbert holds that the inhaled bacilli traverse the alveolar wall without being changed, reach the bronchial lymphatic glands, and there provoke a tubercular infection. Occasionally they then break into the blood-stream, and reach the apex of the lung for a second time with the circulating blood, and infect either the smallest bronchioles or the alveolar passages. It is not yet decided why they should not do so at first. Other observers uphold the view that the inspired bacilli adhering in the cavity of the nose and mouth are absorbed by the tonsils (Beckmann), the pharyngeal tonsil (Aufrecht), the mucous membrane of the mouth and the lingual tonsils (Westenhoeffer for children), and are transported through the lymph-channels to the cervical glands, and from thence to the bronchial and mediastinal glands, pleura, and apices of the lungs, or into the arterial blood-stream. But apart from the rarity of primary tonsil tuberculosis it is certain that a direct connection between the cervical and the bronchial or mediastinal glands does not exist in all under normal conditions. The supporters of the infection of tuberculosis through the blood-stream place their reliance chiefly on the frequently found tubercular affection of the small arterial branches in early tuberculosis. The possibility of such an explanation will be by no means contested, but only its general applicability. According to Lüharsch the frequency of disease of the small arteries in advanced, and especially in very pronounced, pulmonary tuberculosis speaks strongly against its primary nature. Also Orth, who first recognized the affection of the small vessels, did not consider that it supported the view of the frequency of lung infection through the blood-stream. On the contrary in advanced lung tuberculosis one can see microscopically the overlapping of the processes in the bronchioles and arterial walls.

**Infection through
the
Intestinal Canal.**

The teaching of v. Behring that infants' milk is the chief source of lung tuberculosis has again brought up the question of enterogenous infection. This view of v. Behring, founded on the long latency of tubercle bacilli in the lymphatic glands, was well grounded, but, as a general explanation, has only received small support. This mode of infection was energetically advanced by Calmette and his school. Their feeding experiments, in which they claim to have produced anthraxosis through the intestinal tract, cannot be confirmed if proper precautions are taken; but have rather been explained as an inspiration infection

due to experimental errors. Infection through the digestive tract is not only concerned with food derived from tubercular animals, but also with bacilli of human origin. These acquired by inhalation or from infected food, table utensils, the fingers, &c., may remain in the mouth, and being swallowed with the saliva or food, may be carried to the digestive organs. Thus can be produced a primary tuberculosis of the tonsils, the lymphatic glands of that region, the intestines, the mesenteric glands, or other organs; a mode of infection which we, following B. Frankel, may call deglutition tuberculosis. This process, however, is rarely met with; a progressive tuberculosis does not begin in this way, and it is only seen in children.

Varieties of Tubercle Bacilli.

A change of views has taken place concerning the transmission of animal tuberculosis to men since Koch's work on the differences between the organisms producing human and bovine tuberculosis, a subject on which there is still no complete agreement. From the labours of various commissions appointed to inquire into this question both in Germany and elsewhere, the following results have been obtained. There are two types of tubercle bacilli, one peculiar to men and the other to animals, which are best distinguished as the human and bovine types. It is certain that the human type of tubercle bacillus is not pathogenic for cattle. In nearly all of the large number of cases of phthisical sputum examined pure cultures of the human type could alone be grown. Those cases of human tuberculosis in which the bovine type was found occurred nearly always in children, and the tubercular changes were generally local, and only slightly progressive. The chief source of infection is the phthisical person who coughs and spits. The war against tuberculosis, therefore, must first be directed against human infection and the human type of bacilli.

As the chief deductions to be drawn from these definite experimental results, Kossel, representing the standpoint of R. Koch and the Berlin Institute of Infectious Diseases, enunciated the following propositions at the seventh International Congress of Tuberculosis, held at Rome this year (1912). Human pulmonary tuberculosis is with very few exceptions to be traced to an infection with bacilli of the human type. The source of infection in consumption is almost exclusively to be sought in human tuberculosis. The ingestion of tubercle bacilli of the bovine type with the milk or meat from tubercular animals plays a very subordinate part in spreading tuberculosis. In the conflict against tuberculosis results can only be expected from measures intended to prevent or diminish the transference of infection from man to man.

Almost at the same time Orth, in a communication to the Prussian Academy of Science, while acknowledging the necessity of combating infection from human bacilli, comes to a different conclusion on the importance of the bovine bacillus. In opposition to Koch's Institute for Infectious Disease, Orth places the proportion of the bovine infections in tuberculosis of children at 10 per cent, at least. Not only does he consider the causation of pulmonary tuberculosis by bovine bacilli to be possible, but he even thinks he has found evidence of it in the fact that an infection with bovine bacilli in childhood, that has been withstood, may predispose for a later outbreak of lung tuberculosis. Orth ascribes particular importance to the discovery of the so-called transitional forms of tubercle bacilli, which he calls atypical varieties. Those forms of bacilli which are found in the majority of cases of lupus, and which Eber especially has succeeded in cultivating, he takes as evidence against the unchangeable stability of both types. According to Orth the bovine bacilli play an important part in tuberculosis of children and in lupus, and "human tuberculosis can never disappear as long as fresh bovine bacilli are constantly being transferred from animals to mankind."

5. HEREDITY.

Before the discovery of the tubercle bacillus it was natural to look for an explanation of the dissemination of tuberculosis in the constitutional factor of heredity. That one generation after another was carried off was by this means most easily explained. But even to-day the pre-natal transmission of the tubercle bacillus has celebrated supporters; not permanently, however, since according to recently developed theories we are not able to find a satisfactory explanation of it, though we cannot deny its possibility altogether. At their head stands v. Baumgarten: "The bacillus lives not only with man and through him, and does not only die with him, but accompanies him in his propagation from generation to generation." This view is built, much more than any other discussed theory, on the idea of a long latency for the tubercle bacilli, and indeed v. Baumgarten assumes for the tubercle bacillus an individual state of existence, still unknown to us, like the spores of other bacilli, in which form it emigrates from the father directly into the offspring.

As it has not been proved that the bacilli enter the spermatozoon itself, v. Baumgarten considers that the germinative transference from the father has been demonstrated by the experiments of Friedmann, who found in animals bacilli mixed with the sperm,

which was thus transferred to the fœtus, and later into the different organs, while the mother remained free from tubercle. The facts discovered by the same observer of the infection of the ovum within the ovary from a maternal tuberculosis are possible but rare. There has lately been an attempt to explain by this theory of v. Baumgarten's the fact that guinea-pigs can be infected from the organs of the fœtus of other tubercular guinea-pigs, though in these foetal organs there are no tubercular changes, and no tubercular bacilli can be detected.

On the other hand the transference of tubercle bacilli through the placenta to the embryo is much more common; placental tuberculosis offers a proof of this. In fact the number of discoveries of tubercle bacilli in placentas, which are normal to the naked eye, is increasing from day to day, owing to the recent introduction of the accurate anilin method of Uhlenhuth making possible the breaking up of whole pieces of organs, whereby the discovery of tubercle bacilli is greatly facilitated. v. Baumgarten lays stress on the fact that it is just the early forms of disease of the placenta, which can only be recognized with difficulty, that lend themselves particularly to the transmission of the disease; and that the less the organ itself suffers from the bacilli the more easily will these be driven on by the circulation into the body of the fœtus. He also supports the view of the hereditary origin of the tubercle bacilli which are frequently found in the enlarged lymphatic glands of new-born infants and of children of a year old. The tracheo-bronchial glands are found to be especially affected, so they have acquired a particular significance in the production of tuberculosis; the disease from them infecting the body through the lymphatics and blood-stream.

By those ingenious views of ante-natal infection, v. Baumgarten thinks to have avoided all the difficulties which are opposed to the incomplete demonstration of infection through the air and intestinal tracts as the usual, frequent, everyday modes of entry of tuberculosis; he considers, however, the view of inhalation infection as useful, and also admits intestinal infection as a partial explanation.

The views of v. Baumgarten are in opposition with the results of the very numerous cutaneous tuberculin tests; new-born children give, nearly without exception, no reaction, even when the mother shows a positive reaction. Therefore up to now the view of the germinative origin of infection has been accepted by very few observers; and the development of an infected ovum is considered very unlikely. Transference through the placenta, which is after all rare, is really an inter-uterine infection; and so,

properly speaking, cannot be acknowledged as hereditary transmission. What can be transmitted is only the susceptibility to infection, the predisposition.

6. PREDISPOSITION.

Careful *post-mortem* examination (Nägeli, Schmoel, Lübarsch, &c.) has shown the great frequency of tubercular deposits, especially in the lungs and their lymphatic glands. As, in spite of this frequency, which must not, however, be taken to mean universality, only a part of mankind is carried off by tuberculosis, there must be some circumstances in existence which modify the progress of the disease; the assumption of a predisposition cannot be excluded. There is a distinction now between inherited and acquired predisposition.

Hereditary Predisposition.

There is still some obscurity about the question of an hereditary specific predisposition. There are prominent observers who only allow it a small place in the aetiology of tuberculosis, adducing the example of races in a state of nature (Negroes, Arabs) in whom tuberculosis is practically unknown, so that they can have no specific hereditary predisposition, yet who quickly succumb when exposed to the contagion in civilized countries. The importance given to the factor of hereditary disposition is also diminished by the reduction of tuberculosis which has now been secured, and even more by the success in averting infection and raising the natural resistance, which has been obtained by improvements in the hygienic conditions of life. The faulty development and the anatomical weakening in the tissues of those from a tubercular stock may be rather considered as results of the already acquired latent tuberculosis, than as causes of the predisposition to the disease. We are inclined to assume the existence of a marked manifestation of the disease in earliest life rather than a strong predisposition. On the other hand, it is quite possible to conceive that part of the bodily inferiority is a consequence of the damage to the germ plasma by the tubercular virus. A new impetus towards the better comprehension of hereditary predisposition has been given by Turban's idea of the transmission of a *locus minoris resistentiæ*, or weak spot, for tuberculosis. Turban could prove in more than a hundred cases that pulmonary tuberculosis in members of the same family (descendants or collaterals) began in the same part of the lung. It may be a question here of the hereditary transmission of a faulty structure of part of an organ, a weak anatomical development, or a local tissue weakness:

for example, an impaired resistance of the elastic fibres (Hess). The striking similarity in the localization of pulmonary tuberculosis in persons who are related is confirmed by Strandgaard.

Besides tuberculosis itself the following are generally considered as causes of hereditary predisposition: Other wasting diseases (cancer, diabetes), generally bodily weakness, old age, inbreeding, &c. According to Brehmer, in large families it is especially the youngest children, and in turn their descendants, who are liable to tuberculosis. This hereditary tendency may be also seen in very weak premature children, twins and triplets. An innate predisposition also awaits the children of life-long food eaters, a fact to which Brehmer has again drawn attention.

In connection with the hereditary predisposition may be considered the question of the fertility of the tuberculous and its biological importance for the race. According to the interesting and careful observations of Weinberg tuberculosis does not occur with any special frequency in fertile families; the fertility also of tubercular people is not increased, but seems even to be considerably less than that of the non-tubercular, and the children of tubercular parents have a markedly higher mortality than those of unaffected parents.

The reason for the inborn predisposition lies principally in a defective development of certain organs, especially the thorax and its contents, which is described by the term *phthisicoid chest*. As more or less well recognized distinguishing marks there have been described stenosis of the upper part of the thorax (Freund, Hart), smallness of the heart, and abnormal constriction of the large blood-vessels, aorta, and especially the pulmonary artery (Lebert, Benecke).

The existence of smallness and weakness of the heart as a primary abnormality is, however, by no means certain. The affirmative opinion held by Laënnec, Louis, Bixot, Rokitansky, and Benecke has been developed further by estimations of the volume of the heart, and by recognition of the frequent constriction of the main arteries. A support for these views was found in Virchow's observation of hypoplasia of the large arteries and its importance in chlorosis. Brehmer successfully upheld the view that the small heart with too large lungs is an important element in the predisposition to phthisis. We can to-day take it as a settled fact that a number of phthisical patients, and even those with an asthmatic chest, have a heart below the normal size as a primary constitutional abnormality. On the other hand, we have also the recent work of Müller, and especially of Hirsch, who by weighing the heart have shown that the small size of the

pulviscal heart is analogous with the general cachexia, and that the diminution in size of the organ runs parallel with the wasting of all the muscles of the body.

**Acquired
Predisposition.**

Towards the production of an acquired predisposition there are a large number of local and general factors, which cannot, however, be sharply separated from each other. Among the local predisposing factors the diseases of the various organs play a chief part, e.g., mechanical injury to the tissues, disorders of nutrition and circulation, and pathological changes in the tissues from other infections. The most important general predisposing influences are under-feeding, anaemia, constitutional and nutritional changes, bodily and mental over-fatigue, serious nervous and psychical disturbances, infectious diseases, and toxic conditions (syphilis, alcoholism). So far as the predisposition for tuberculosis is of importance for different organs it will be considered under the separate headings. We will only consider a little here the predisposition for lung tuberculosis, as the general predisposing causes for this have also more or less importance for tuberculosis of other organs.

The overwhelming relative frequency of tubercular deposits in the lungs is ascribed to the peculiar arrangement of these organs equally by supporters of the views of infection through the air-passages and the blood-stream. Just as the inspiratory air-currents bring the tubercle bacilli to the smallest bronchioles where there is the least movement, so also the whole volume of venous blood is brought to the lungs, with the lymph from all the lymphatic channels. The slowing of the blood-stream in the pulmonary capillaries favours the deposition there of any bacilli in the circulation. The special predisposition of the lungs is also shown by the fact that suitable experiments, even on slightly susceptible animals, succeed in producing tuberculosis limited to the lungs, no matter by which channel the infection is produced; and by the further experimental result that infection by inhalation of a very small number of bacilli takes place in the same way as infection, for example, through the intestinal canal.

**Local
Predisposition.**

Among the local causes of predisposition to lung tuberculosis stenosis of the upper aperture of the thorax is of the first importance. Its occurrence was first recognized by Freund, the causes of it have lately been investigated by Hart. The first rib on one or both sides is shortened, bent, or lengthened; the cartilage is ossified, abnormally short, or quite absent; there is thus produced an encroachment on the upper aperture of the thorax, on

one or both sides. By the narrowing of the first thoracic ring the next ribs will be interlined with, leading to a flattening and diminished expansion of the upper part of the chest, so that the apices of the lungs are unfavourably affected both in form and function, and the phthisical chest is thus produced. There is, in consequence, not only a deficient entry of air, but, what is of more importance, an impaired circulation, engendering a weak spot favourable to the lodgment and growth of tubercle bacilli. Pulmonary stenosis affords a classical example of the fact that a deficient circulation through the lung increases the disposition to disease, for a very large proportion of these cases die of tuberculosis. The anomalies of the first rib, according to Hart, are either congenital or are developed secondary to a fixation or curvature of the cervical or upper thoracic vertebrae (scoliosis, kyphosis). They are also frequently the consequence of rickets (rickety thorax, pigeon breast, shoemaker's chest), and states of congenital or acquired debility, giving rise to a paralytic thorax, which is separated by Hart from the phthisical chest. These do not often appear in childhood, but from puberty onwards. This explains why the lung apices in children are not so particularly liable to tuberculosis; also in them the lungs do not lie so high in the upper aperture of the thorax.

These abnormal arrangements of the first rib are in agreement with the discovery of Birch-Hirschfeld, who was able to recognize in lungs affected by early tubercular deposits a bending and stunting of the ramifications of the posterior sub-apical bronchus; and the first onset of tuberculosis was just in the territory of this bronchus. The encroachment on the size and capacity of the apex of the lung was confirmed by Schmorl, who frequently found the formation of a groove in lungs compressed by an abnormal first rib. These furrows correspond accurately with the distribution of the posterior sub-apical bronchus, which Schmorl also recognized as a site of predilection for early tuberculosis. The systematic examinations of Hart have confirmed the connection between these abnormalities and the consequent mechanical predisposition of the apices to tubercular disease. Baumeister has lately succeeded in producing experimentally on young rabbits an isolated apical tuberculosis at the point of pressure, by causing a gradual aperture stenosis with consequent pressure of the underlying lung apex, and afterwards setting up direct and indirect hæmatogenous infection.

As further acquired predisposing influences the following are of weight: slight injuries to the smallest bronchial tubes from inhalation of particles of mineral, metallic, vegetable, or animal

dust. The harder, sharper, more pointed the dust particles the more likely are they to injure the lung tissue, to open the way to tubercle bacilli, and to favour their development by setting up chronic inflammation. Likewise some substances, as corrosive vapours and gases, cause chemical injuries. As anatomical lesions may be caused by various fine mechanical irritants, so gross traumatic injuries from direct or indirect violence (punctures, shots, blows, falls, and crushing) produce injury to the lung tissue, and favour possible infections. But much more frequently it will happen that a latent inactive focus, usually in the bronchial glands, is brought into activity by an injury, or a latent but active tuberculosis made evident; which, however, is the same thing from the legal point of view. Injurious also are catarrh and inflammation of the smaller air passages and of the lungs (bronchitis, pneumonia, measles, scarlet fever, whooping cough, influenza) from epithelial damage, retained secretions, and inflammatory products, opportunity being thus offered to the entrance and lodgment of tubercle bacilli. But these diseases, especially measles and influenza, much more frequently cause the manifestation of a hitherto latent tuberculosis. Lastly, we must recognize the predisposing influence of hampered respiratory movements due to pleural adhesions, which renders the expulsion of intruding bacilli more difficult, and facilitates their development; but here, too, we must remember that pleurisy is very often the first symptom of a hitherto quiescent tuberculosis.

General

Predisposition.

Mention will only be very briefly made of the more important of the general diseases and of other causes favouring infection: anaemia, chlorosis, deficient air and light, unhealthy dwellings, long hours in close rooms during work, particularly such occupations as involve much sitting, unfavourable climate and climatic changes, under-feeding, chronic stomach and intestinal disease, nutritional and constitutional affections, blood diseases, extreme debility following severe infections (typhus, rheumatic fever, malaria), advanced nervous disease, syphilis, chronic gonorrhoea, alcoholism, sexual excess, dissolute life, physical and mental overstrain, psychical depression, grief and anxiety, numerous and too frequent confinements, severe labour, puerperal complications, over-prolonged suckling, &c. All these diseases and bad conditions, which may be met with in many combinations, induce a predisposition by lowering the powers of resistance of the whole organism or of individual organs, and increase the probability of infection by diminishing the natural resistance of the normal cell; presuming that there is sufficient exposure to the disease. There

is also in a certain sense a predisposition when the before-mentioned morbid influences only choose the critical moment for rendering the disease active, or for aggravating latent disease, which in an individual case is not always easy to recognize, and in practice comes to the same thing.

Here it may be mentioned that to certain diseases as gout, nephritis, asthma, emphysema, and many forms of heart failure have been rightly or wrongly ascribed an immunizing tendency. In these conditions the onset of tuberculosis is impeded in fact by venous stasis. As is well known, Bier has applied the principle of congestion hyperæmia to the conservative treatment of tubercular bones and joints. The general statement of Rokitsky, that there was an antagonism between all forms of valvular disease and tuberculosis, has been limited by Traube and v. Leyden principally to mitral stenosis. It is certain that mitral stenosis, of all forms of heart disease, is most rarely combined with lung tuberculosis, and that pulmonary tuberculosis is relatively seldom found with all forms of mitral disease, which produce brown induration of the lung tissue in consequence of chronic venous congestion. v. Rumberg, who holds the view that the infection in pulmonary tuberculosis occurs through the blood, explains the difficulty the bacilli have in finding a lodgment in these cases, by the mechanical dilatation of the smallest lung capillaries in consequence of the congestion.

Age and sex likewise affect the nature, onset and course of the disease: the male sex is more liable, and in both sexes the period of development is the most favoured. The causes for this lie only in the individual himself. More important is the presence and number of the above-mentioned causes which bring on and maintain the disease.

Race and Immunity.

If there is a difference in the susceptibility of different races to tuberculosis, it is not yet well understood. Many observers maintain the existence of racial predisposition. "The phthisical tendency is diminished for the northern race, just as the apoplectic tendency is for the Alpine, brachycephalic race" (Sofer). The argument of a racial predisposition is not in itself very powerful; in animals quite small differences of race are of greatest importance in resisting equal infections. On the other hand, the idea of a racial immunity, which has been asserted on many sides, may really be due to small opportunity of infection, and circumstances in the home-surroundings unfavourable to the growth of bacilli. But if tuberculosis is imported into such hitherto more or less unaffected countries, it shows itself in a more acute and

severe form and has a malignant course, as Deycke has shown for Turkey. This brings us to the question of race immunity, which Reibmayr thinks to have proved for single families, who in the struggle for life have acquired and handed down from generation to generation a resistance to tuberculosis by having recovered from the disease. This is also affirmed by Sefer for the whole northern race. In support of this we have the severe nature of tuberculosis when imported into new countries, as mentioned above. There is an analogy in syphilis which becomes less severe when the epidemic has passed through a series of generations, as among the Indians.

In connection with the development of immunity there is the idea that a favourable course of a case of chronic adult tuberculosis is caused by a relative immunity conferred by recovery from a mild infection in childhood (v. Behring and Roemer).

CHAPTER II.

Pulmonary Tuberculosis.

I. ANATOMICAL CHANGES.

BEFORE discussing the anatomical changes in the lungs, we may review shortly the various forms of pulmonary tuberculosis according to the mode of entry of the bacillus. Following the classification of Heller, we may distinguish: (A) Primary "inhalation" pulmonary tuberculosis (1) of the alveoli, (2) of the bronchioles, (3) of the lymphatic follicles of the lung; and (B) Secondary tuberculosis of the lung (4) by inhalation, (5) through the blood-stream, (6) through the lymphatics, (7) and by direct rupture of a lymphatic gland into the air passages. The initial localization of pulmonary tuberculosis may therefore take place at various sites, and it is further influenced by the special liability of the apices.

Tubercles and Caseous Nodules. The initial tissue changes in the formation of tubercles and their various later modifications have already been described in the section on the histology of tubercle. By an extension of these processes, several small tubercles at the same point caseate in their centre, join together and form a caseous nodule of varying size. These, like individual tubercles, may become encapsuled by connective tissue growth and undergo calcification; or the caseous contents may soften and break through into a bronchus. There is thus formed a small cavity; and the previously closed tuberculosis has become open, permitting the escape of secretion containing bacilli into the bronchial tubes and so into the outer world. By the emptying of its caseous contents, and the formation of granulation tissue, a cavity may become gradually smaller, and by cicatricial contraction may entirely heal.

However, if the process is not arrested, the disease spreads by continuity, or through the lymphatics, blood-vessels, or air-tubes. The further pathological changes are extraordinarily



Lower Portion of the right lung, cavity and tubercular bronchitis in the middle lobe.



Typical Aspiration Tuberculosis.

Bleeding phlebotomy, slate-colored induration of apex with bronchiectasis and dense cavities.



multiform, according to method by which the dissemination occurs, to the number and virulence of the bacilli, and the predominant action of the bacilli themselves or of their toxin. The tissue change may be of the nature of exudation, proliferation, or necrosis, especially caseation. A sharp division between these various pathological processes is not possible; generally they are all found together, sometimes one is more prominent, sometimes another, according to the resistance of the various lung tissues. The following are the principal forms that can be distinguished.

**Tubercular
Bronchitis.**

If the tubercular process begins in the wall of a small or medium bronchus, as appears to be most often the case, it consists of a sub-epithelial infiltration, spreading towards the periphery of the wall—tubercular bronchitis. It is important to notice that this newly-formed tissue near the surface ulcerates easily, and that this variety becomes very early an open tuberculosis. The tubercle bacilli soon grow into the peri-bronchial and peri-vascular lymphatics, and so develop a new series of nodules along the bronchioles and blood-vessels.

**Tubercular
Peri-Bronchitis.**

Out of tubercular bronchitis develops the well-known macroscopic peri-bronchitis. But the development of one form from the other may be at times reversed. In the originally grey, later yellow, foci there can be still seen at first the open lumen of the bronchiole, which becomes gradually blocked by necrosis of the growing cells. Through wider extension and fusion of neighbouring foci there appears what is known clinically as diffuse tuberculous infiltration. The peri-bronchial foci may caseate in the centre, and the bronchial lumen be expanded into an irregular space, the beginning of a cavity. But generally these chronic processes tend to limitation and healing. Round the tubercular deposits and small caseous infiltrations there is a growth of connective tissue forming a fibrous capsule, leading later to contraction and cicatrization. The isolated, encapsuled, caseous masses calcify; whether softened caseous material can be re-absorbed is doubtful.

Induration.

By diffuse connective tissue overgrowth large parts of the lung, especially at the apices, may become airless and quite indurated with fibrous infiltration. These indurations consist of firm, tough, blue-grey or slate-coloured fibrous tissue. In consequence of the contraction the bronchial tubes in the neighbouring areas of the lungs are usually dilated; bronchiectasis is thus produced, and under

the strain of great contraction bronchiectatic cavities. Compensatory emphysema is often found surrounding the shrunken lung areas. Such indurative processes, which have a very chronic course and a relatively favourable termination, are included under the head of fibroid phthisis.

**Caseous
Pneumonia.**

Involvement of the alveolar tissue gives quite another anatomical picture, and is brought about by aspiration of infectious material into healthy lung, collapsed from bronchial obstruction. Exudation is a prominent feature; the alveoli are filled with a tenacious, albuminous, fibrinous mass, with epithelioid cells, leucocytes, and red blood-corpuscles; thus producing caseous hepatization. According to the arrangement of the lesions in single scattered foci of various size, which have not necessarily arisen at the same time, or in large patches, the disease is distinguished as lobular or lobar caseous pneumonia.

**Transitional
Forms.**

Caseous bronchitis may also be produced, the inspired infective material not reaching the alveoli, but only the bronchi and bronchioles. Varieties of this process, brought about in a similar way, have been distinguished as desquamative pneumonia (Buhl), glazed pneumonia (Virchow), and gelatinous infiltration (Lamner); inflammatory processes that are still capable of complete reabsorption. They owe their production, probably, to the inspiration of material which is only slightly infective. When due to scanty bacilli caseous pneumonia presents a transitional form with small caseous islets.

**Cavity
Formation.**

Small caseous foci can become encapsuled and calcified; larger caseous areas soften and form cavities. By degrees the cavity opens into one or more bronchi, and the fluid contents are expelled. Under favourable circumstances the cavity may become quite clean, grow smaller and smaller from the formation of granulation tissue, contract up entirely, and be converted into a puckered cicatrix. Such a process leads to great contraction of the lung, with marked flattening or retraction of the chest wall. If the cavity is too large, or the contraction prevented by adhesions, the next most favourable outcome is that it may be healed by the formation of a firm, smooth, pyogenic membrane; but the cavity remains open, and for its possessor there is always the threatened danger of a secondary infection from without. If the tendency towards healing is deficient the destructive process extends at one or more points, neighbouring cavities may coalesce, and other complications may assist in the destruction of pulmonary tissue.

**Mixed
Infection.**

The view has up to now received general acceptance that secondary pus-producing organisms (chiefly *Streptococci*, more rarely staphylococci and diplococci, &c.) may gain entrance, especially into cavities, but also into fibrocaseous nodules not undergoing destructive changes. This chronic, active, mixed infection makes the disease more severe and produces characteristic fever; the tubercle bacilli open up the way and a rapid tissue destruction follows. The secondary entry of highly virulent bacilli is the chief cause of the rapidly destructive process known as florid phthisis. According to the recent excellent observations of Kögel, the importance of chronic mixed infection in pulmonary tuberculosis has been considerably over-rated. As the result of very careful work on the hæmolytic properties of the concomitant bacteria, he has come to the conclusion that the saprophytic septic organisms found in the lungs only acquire the power of penetrating into the tissues after the resisting powers of the organism have been weakened by advanced disease, and that the *Streptococcus longus* is of much less importance than the *Streptococcus pyridans* and the non-hæmolytic staphylococci.

**Involvement of
the Vessels.**

The very frequent occurrence of hæmoptysis in the course of phthisis demands a few words on the anatomical involvement of the vessels. In tubercular deposits the small vessels usually become obliterated by endarteritis; larger vessels acquire a thickening of their walls, which gives them great resisting powers to destructive process; a good example of which is seen in the strands and ridges containing vessels which are found in cavities. Tubercle can, however, develop in healthy vessels, an event which the supporters of the vascular origin of pulmonary tubercle claim to be a regular occurrence; at any rate, hæmorrhage, from the breaking down of such vessel-wall tubercles, is an early symptom of commencing pulmonary tuberculosis. Also the rupture of a small over-stretched vessel in a tubercular bronchiectasis may be the cause of an initial hæmoptysis. Severe bleedings generally come from a distended or aneurismal large vessel in a cavity.

**Miliary
Tuberculosis of the
Lung.**

By the rupture of a tubercle on a vessel wall and entry of sufficient number of bacilli into the circulation, miliary tuberculosis is caused. In this condition the lung is crowded with tubercular nodules, which are either of equal size throughout the lung, the uniform variety, or are the largest in the upper parts of the lungs and smaller and more uniform in the lower parts, the form of uneven distribution, which by many

observers is called the chronic form of miliary tubercle. The reason of the pathological arrangement in these cases is not clear, and will be referred to later in the chapter on miliary tuberculosis.

**Pleural
Complications.**

The most frequent complication of pulmonary tuberculosis is pleurisy, which in its various forms will be especially considered under tuberculosis of the pleura. By the opening of superficial caseous foci or cavities into the pleural space, pneumothorax is produced, which by the entry of caseous debris may be converted into a pyo-pneumothorax.

**Tuberculosis
of the
Bronchial Glands.**

A very common complication is tuberculosis of the bronchial glands, which, especially in young individuals, is seldom absent. The condition of the glands is very varied. Often there are only small latent nodules, or single retrograding caseous foci; in other cases the glands are swollen and markedly infiltrated; out of these may be produced large masses, with calcified or partly softened and gritty contents.

The anatomical changes in these structures and in the other organs, both in connection with chronic pulmonary tuberculosis and when separately affected, will be considered in later chapters.

2. SYMPTOMS AND COURSE.

The usual course of pulmonary tuberculosis offers a typical example of a chronic disease. It may last for years; it may remain latent for long periods; it may heal without ever being recognized; after long periods of apparent arrest it may break out again and progress; according to the diversity of the anatomical changes it may manifest itself in very various ways; in its slow progress it may gradually sap the strength of the patient, without causing him bodily suffering, his pleasure in life and power of work remaining almost to the last; or it may, through various complications, change for the worse at any time, rapid aggravation or even sudden death occurring. It must also be noticed that a special character may be given to the course of the disease, according to the powers of resistance to the various processes possessed by the organism; that the number and virulence of the bacilli, the predominance of the organisms themselves or of their toxins, or the addition of various septic microbes, may cause extreme variations in the form of the disease; so it is only to be expected that the clinical symptoms of phthisis should be extraordinarily multiform. So long as a closed tuberculosis is purely local, clinical symptoms are almost entirely absent. We

know that even fairly extensive changes may long remain latent. When products of cell destruction and bacterial poisons are set free and absorbed, general symptoms make their appearance. It is the secondary tissue destruction which first points clearly to the presence of disease of the respiratory organs, and causes the distinctive lung symptoms.

These few observations must suffice to show that in the description of the symptoms of phthisis given in this work it is only possible to give a representation of the most marked features.

Cough.

One of the most early symptoms is the cough, which is generally produced by secretion irritating the vagus nerve-endings in the bronchial mucous membrane. It varies much in different individuals and at different times; generally it only appears in the morning, or is worse then; sometimes it is most frequent during the night or at bed-time. It may be of any severity from the slightest cough to a tormenting, barking paroxysm causing vomiting.

Generally expectoration is connected with the cough, but the two do not always run parallel with each other; on the contrary, the cough often diminishes so soon as the sputum becomes more abundant and therefore more easily expectorated; and it is often most troublesome when due to the scanty, tenacious, chemically irritating secretion of the early stage of the disease, which causes intense irritation of the bronchioles, and produces the sensation of a foreign body.

The cough caused by pleuritic irritation, by large bronchial glands pressing on the vagus, and by other various causes of reflex cough, is of special symptomatic signification.

Expectoration.

Expectoration is by no means an early symptom. By careful inquiry one can determine that it regularly appears decidedly later than the cough. Cases of early tuberculosis in public sanatoriums, for instance, have no sputum in a large proportion of cases. Of course, patients pay little attention to slight expectoration; they, especially children and females, frequently swallow it. At first it consists of frothy, glairy, tenacious mucus, like frogs' spawn, containing scattered points of blackish pigment. Later it will be more turbid, on account of the proportions of formed elements, contains yellowish spots and streaks, and is more abundant and purulent. Sputum from a cavity is almost pure pus, more grey however than yellow, only slightly mucoid; it is nummulated, or in small lumps, and sinks in water as it contains but little air; the rounded pieces with irregular, rough surfaces reveal their

origin. Small calcareous particles (lung calculi) are also occasionally found.

The quantity of expectoration is very variable. In the fibroid forms of phthisis, on account of the blocking of the blood-vessels and lymphatics, it is scanty, and may be completely absent even in extensive disease. With cavity formation it is at its greatest; it is brought up periodically, especially in the morning, in large quantities, generally with continuous coughing.

Sputum has a sweetish taste and a faint odour, only after standing does it become unpleasant or foetid.

Besides the tubercle bacilli, which, even in extensive disease, may be absent when the expectoration is scanty, there may be found in sputum a series of other bacilli, which may be either harmless saprophytes of no importance (passive mixed infection), or those with unfavourable influence on the course of the disease (active mixed infection).

Though they may be found in any form of destruction of the lung tissue, the discovery of elastic fibres in the sputum is of great importance; they are at first to be sought for in small particles derived from cavities, which may be recognized by the naked eye.

Hæmoptysis.

Coughing up of blood is a symptom of practical importance and of considerable diagnostic value. Small points and streaks of blood may be due to non-specific catarrhal lesions of the mucous membrane of the pharynx and upper air-passages; but they may also be the forerunners of a larger hæmorrhage. An hæmoptysis is not seldom the first symptom of a hitherto latent tuberculosis; it may, however, appear at any stage of the disease. All grades, from a tiny trace of blood, to a fulminating fatal gush, may be met with. Apart from small bleedings, it is a symptom of excavation. In rare cases it is the result of the breaking down of a tubercle of the vessel wall, more usually, especially in advanced cases, it occurs in consequence of a rupture of an aneurismal vessel in a cavity. The bleeding commences either quite without reason or in consequence of some exciting cause (over-exertion, traumatism, attack of coughing, sneezing, emotion, &c.). There is no possibility of being able to account for its onset or course with even approximate accuracy, for centrally situated softening in the lung may be quite beyond physical recognition. The more chronic the course of the tuberculosis and the more fibrous its character the less the tendency to hæmorrhage. Sometimes large hæmorrhages are ushered in by traces of blood, pain in the chest, or tickling in the throat. Sometimes patients, who have already

had hæmorrhages, will complain of a taste of blood in the mouth before a fresh relapse. It is well known that climatic influences, changes in the atmospheric pressure, excessive moisture in the air, great heat, sultriness, storms, &c., favour the occurrence of hæmorrhages; but definite knowledge on this subject is wanting.

The quantity of the blood and the frequency of the bleeding vary much. Small hæmorrhages are usually recovered from, unless they are accompanied by other complications. More severe hæmoptysis is generally a serious complication, both from the prostration of the patient, and from extension of the tubercular process, owing to aspiration of blood mixed with contents of the cavity. It may also be the immediate cause of death from loss of blood, suffocation, or collapse.

The course the hæmoptysis takes depends on the size of the aperture, on the calibre and condition of the vessel, on the physical opportunities of the formation of a thrombus (the size and situation of the cavity and its bronchus, the amount of secretion), on the viscosity of the blood, on the blood-pressure, and lastly on the conduct of the patient. It is also important, especially for treatment, to know whether the bleeding is arterial or venous; which certainly is not always easy to determine. The arteries of the lungs give dark venous blood, the veins light red. Arterial bleeding is checked with more difficulty, and returns more frequently. To account for the varying liability of apparently similar patients one is inclined to assume a predisposing disposition, which is in accord with the differences found in the vessel wall microscopically. Of more importance for the estimation of the effect of the hæmoptysis on the course of the disease is the behaviour of the temperature; the absence of fever, or only a short and moderate fever of re-absorption, is a favourable sign; the occurrence of continued fever points to an advancing disease.

Pain.

Pain is not a constant symptom of pulmonary tuberculosis; even advanced disease may progress entirely without it, while in other slighter cases it may be a prominent symptom. The lung tissue itself does not feel pain, so that rapid excavation may occur without it. The chief causes of the complaints of stabbing pain are affections of the pleura; the more rapidly they appear, the worse the pain, as is well seen in acute, dry pleurisy.

The site of the pain depends chiefly on its origin. Wandering, non-localized, intermittent pains will also frequently be complained of; they are brought on by respiratory efforts, coughing, laughing, pressure, percussion of the chest, &c. Pleuritic irritation, inflammation and adhesions, also enlarged thoracic

glands (sternal, mediastinal, bronchial) often cause these pains. Lastly, in the skin over the affected lung areas reflex hyperæsthesia and intercostal neuralgia are occasionally in evidence.

Dyspnoea.

Breathlessness is also a very variable symptom. It depends partly on reduction of the lung area, partly on nervous causes (vagus irritation). The production of dyspnoea by the first cause, and its severity, if produced, depend on the rapidity of the destructive processes. An acute, sudden pneumothorax produces great shortness of breath, while a slowly evolved phthisis with extensive destruction causes hardly noticeable breathlessness. This is due to the patient becoming gradually accustomed to the conditions, and also to the fact that the deficiency of oxygen is obviated in slow disease by increased frequency of respiration.

The dyspnoea is generally brought out by exercise, intercurrent catarrh or fever, and may be considerable in amount. In other cases there may be short, rapid attacks of dyspnoea due to irritation of the vagus nerve-endings by tubercular deposits, or to pressure on the trunk of the vagus by inflamed or calcified endothoracic glands. In this way there may be produced considerable paroxysms of dyspnoea (Jessen) and even asthmatic attacks (Brugelmann, Cornet, Eichhorst). This dyspnoea is influenced by the condition of the general nervous system, as it is observed chiefly in nervous, easily excitable women, girls or children.

Hoarseness.

Apart from specific tubercular disease of the larynx during the course of phthisis, changes in the voice and affections of the vocal organs may be met with, which have more or less importance. In many cases of phthisis the voice keeps its normal tone right to the end, but usually during the course of time the voice loses something of its strength and clearness, and becomes lower, flacker, hoarse and roneless. The causes for this are to be sought in the increasing prostration, the weakness of respiration, and changes in the muscles of the larynx, which in consequence of the strain of coughing may suffer from congestion, catarrh, paresis or fatty degeneration.

Sometimes hoarseness presents itself as an early symptom, due to paresis of the adductor muscles with concomitant laryngeal catarrh. In rare cases the loss of voice is due to paresis or paralysis of the recurrent laryngeal nerve, as a consequence of pleuritic adhesions, or of pressure of enlarged bronchial or mediastinal glands encroaching on the supra-clavicular region. Pressure on the left recurrent laryngeal has also been observed from large pleural effusions and from pericardial exudations.

Fever.

Extreme sensitiveness of the body temperature is characteristic of tuberculosis. Quite moderate exercise or emotion may cause fever; a fact of immediate diagnostic value. The digestive mechanism may act in the same way; therefore it is better to take the temperature after, rather than before, meals. Of special symptomatic importance is the pre-menstrual rise of temperature. It is not even necessary for the maximum temperature to reach the level of fever, unusual oscillations of temperature often have the importance of fever, or at least are suspicious. It must here be noticed that the rectal temperature is only of diagnostic value if its measurement is preceded by complete rest. Under those circumstances the rectal temperature usually runs parallel with the mouth and axillary readings. After physical exercise the rectal temperature alone may rise 2° F., and more above the normal, without the general blood temperature being raised to the point of fever; therefore this rise, which has been considered of importance by many authors, cannot be reckoned as an early symptom of tuberculosis (Staubli).

The cause of the fever is not yet well understood. There are cases, chiefly of the very chronic fibroid forms, which progress to a fatal end practically without fever; but they are exceptions. As a rule fever appears quite near the commencement, and is seldom absent in progressive cases. The chief cause of the fever is absorption of the products of the growth of the bacilli and of the tissue destruction they induce; also the substances formed by the breaking up of the white corpuscles doubtless raise the temperature. Here, too, must be mentioned the rise of temperature due to progressive loss of weight. The next most common cause of fever is the entry of secondary organisms (streptococci, staphylococci, influenza bacilli, pneumo- and diplo-cocci, pyocyaneus and tetragenus bacilli), which in various ways take part in the tissue destruction and fever production, either as more passive accompanying organisms, or by producing the severer symptoms of mixed infection. Whether tubercle bacilli and septic organisms themselves enter the blood—apart from military tuberculosis or during the death agony—and so assist in fever production, there is a difference of opinion, and further observations are required on this point. According to recent researches tubercle bacilli are very commonly found in the blood-stream in pulmonary tuberculosis, their detection being easier the more severe the tuberculosis. The entry of other pathogenic organisms into the blood-stream in uncomplicated pulmonary and laryngeal tuberculosis during life seems to be very exceptional, and only to

occur in very small numbers; they are more frequently found, however, in tuberculosis of the intestines and urinary organs. Straichs has also determined, from *post-mortem* blood examination in 2,000 cases, that the presence of bacteria in the blood is the rule in joint and general glandular tuberculosis and also in advanced amyloid degeneration.

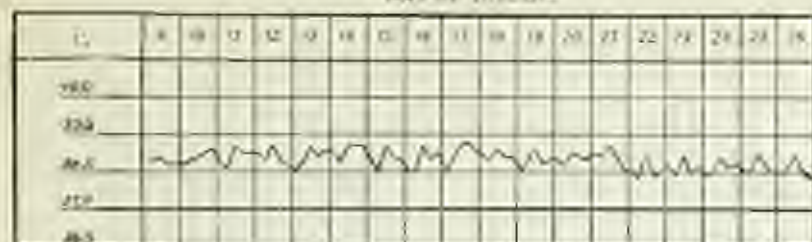
The height of the fever and the course it runs depend on the excitability of the heat centres, and with that on the nervous system and mental state of the patient. It is not possible to separate the fever into fixed types, as it is extraordinarily variable, according to the diversity of the causative conditions; and the individual differences between phthisical patients increases the difficulty.

Slight, irregular rises of temperature, only appearing from time to time in the afternoon or evening, the condition being otherwise favourable, may be considered as sub-febrile. Medium or high temperatures, returning at some time of the day to normal, form the intermittent type; while remittent fever only drops 2° to 4° F. High fever with daily differences of less than 2° F. is reckoned as continuous. Particularly characteristic is hectic fever, which often lasts unchanged for months, and is distinguished by a high evening temperature and a daily morning fall, with a difference of 7° F. or more between the two. Exacerbation of the morning temperature with evening remissions give the inverse type of fever. Collapse temperature (95° to 95° F.) is a particularly unfavourable symptom, so also is a very uneven or changeable temperature curve, of no regular type, or with many exacerbations during the day.

Cyclical periods of fever with afebrile intervals of shorter or longer duration are not rare. A general explanation of this condition is hardly possible, as it may depend on various causes. It may be due to the flaring up and softening of an old nodule, or the outbreak of new tubercular foci around it; or a part may be played by the bronchial glands, by toxic absorption from retained sputum, by entrance of tubercle bacilli into the blood-stream, by recurrent attacks of catarrh due to action of secondary septic organisms. So that an explanation or probable diagnosis can only be given by careful observation of the patient combined with examination of the sputum and possibly of the blood. In chronic fever a change from one form into another is often seen in the same patient. A definite pathognomonic signification cannot be ascribed to the various types of fever; but continued high fever is in every case the mark of an advancing phthisis.

The temperature curve has thus in pulmonary phthisis a high

DAY 14 (HUMAN).



Continuous remittent fever in advanced typhus (human observation.)

DAY 15 (HUMAN).



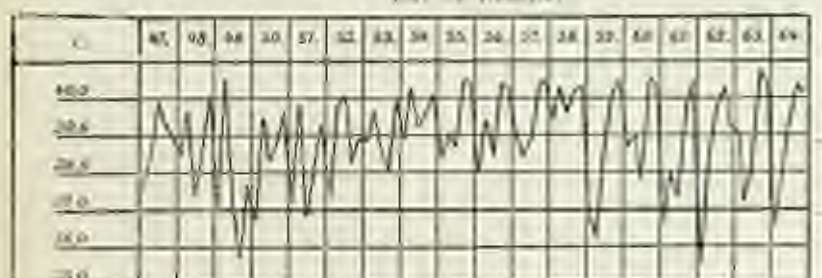
Remittent fever in typhus (human observation.)

DAY 16 (HUMAN).



Intermittent fever in typhus (human observation.)

DAY 17 (HUMAN).



Hectic fever in advanced typhus (human observation.)

DAY 18 (HUMAN).



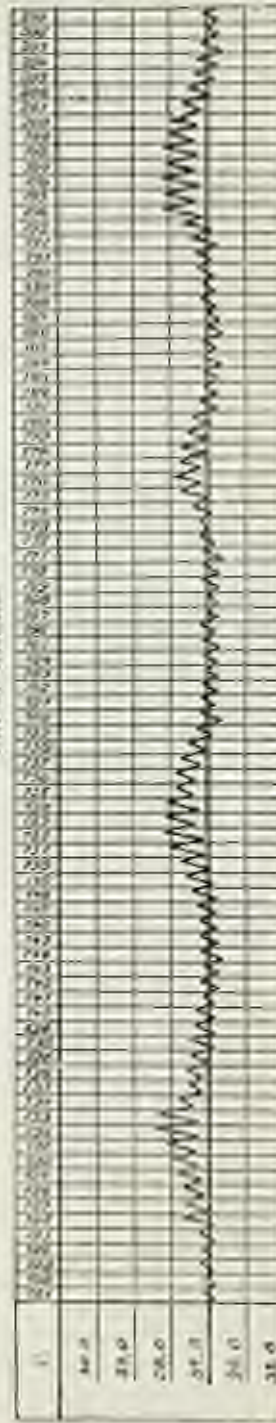
Lower type of fever in advanced typhus (human observation.)

DAY OF DREAM



Typical form as recorded during a very close course.

DAY OF DREAM



Typical form as recorded during a very close course.

diagnostic and prognostic value. All the changes of the many-sided disease, improvements, aggravations and complications are reflected in the temperature chart. The continued control of the progress of the temperature is therefore of the greatest practical importance, and a careful observation of the temperature curve is the indispensable duty of the medical attendant.

Night Sweats.

Connected with the fever is the common symptom of perspiration during the night, although these sweats do not run quite parallel with the height of the fever. There may be any degree of perspiration from slight moisture of the head, hands or feet to a profuse sweat bathing the whole body. Their appearance is subject to individual differences; nevertheless, they so often appear quite in an early stage of phthisis, that they must be reckoned as a pathognomonic early symptom. Also in acute relapses and in rapidly advancing disease they are a regular symptom, and one very annoying to the patient.

The perspiration during the night is partly the result of the fall of temperature from the evening maximum to the morning remission; just as the critical temperature fall in other infectious diseases is accompanied by sweating. Irritation of the sweat centres is very probably another cause, induced on the one hand by the accumulation of carbonic acid, due to the respiratory disturbance, and on the other hand by the absorption of toxins of the tubercle bacilli and other organisms. The tuberculous perspire especially during their sleep, because the diminution of the respiratory surface, which then occurs, favours the accumulation of carbonic acid in the blood (Traube).

It is quite plausible that later the absorbed products of tissue destruction may injure the vaso-motor control centres. This accounts for the sweats being associated with the fever, and indeed with the fall of the latter during the second part of the night, when the blood-pressure and pulse-frequency diminish. That the toxin of the tubercle bacilli actually plays a part here is shown by the fact that the amount of perspiration is incomparably greater in the more acute processes, and that it diminishes under tuberculin treatment with increased resistance to the toxin.

Sometimes unilateral hyperhidrosis is observed, as in many neurotic forms of sweating. This indicates an affection of the nervous system. We know that the secretion of sweat may be induced by irritation of nerve fibres in the sympathetic and central nervous systems (Jessen).

Merely overheating is often enough the cause of night sweats. It is a well-known fact that patients often lose them all at once

on exchanging the warm, stuffy feather-beds of their homes for the hygienic surroundings of a sanatorium.

Symptoms connected with the Circulatory Organs. Absorption of the poisons of the tubercle bacilli causes an alteration of the blood and its chemical condition, setting up a toxæmia, such as can be produced experimentally on animals. The blood changes, which are very soon revealed by a general pallor of the skin and mucous membranes, consist usually of an early diminution of the hæmoglobin content, and, generally only in a later stage, of a loss of red blood-corpuscles. In early stages the lymphocytes are often increased, and this lymphocytosis has therefore a certain amount of diagnostic value.

As the disease advances, especially if mixed infection occurs, leucocytosis is found, the increase in the white cells being chiefly due to a rise of the polymuclear neutrophil leucocytes. Also these leucocytes themselves undergo a qualitative change in the size, shape and number of their nuclei, which, according to the valuable observations of Arnet, have a prognostic importance. The specific gravity of the blood is lowered, its alkalinity diminishes steadily, and the blood-pressure falls more and more, according to the progress of the disease. A lowering of the blood-pressure is considered by many authors a very early sign of pulmonary tuberculosis.

Accompanying the fall in blood-pressure, and due to the same cause, namely, bacterial poisons, there is found acceleration of the pulse-rate. The toxic pulse appears very early and gives rise to a suspicion of tuberculosis when other more certain evidence is not to be found. Secondary causes of the acceleration of the pulse are the mechanical changes in the pulmonary circulation and dilatation of the peripheral vessels. The symptomatic importance of tachycardia from compression of the vagus by enlargement of the bronchial glands may be just mentioned here.

The feeble low-tension pulse is the characteristic expression of heart weakness, which often appears very early and is of weighty import. It, too, is a consequence of bacterial toxæmia and in its last stage is a very frequent cause of death from syncope.

Emaciation, fever and deficient blood circulation tend, in the later stages of phthisis, to atrophy and fatty degeneration of the heart muscle. A soft, blowing, functional murmur over the arterial apertures is often a sign that the heart is exhausted and beginning to fail.

In the chronic blood form of phthisis, in which the area of the pulmonary circulation is progressively diminished, hyper-

trophy of the right ventricle succeeded by dilatation may be detected. Pleural adhesions, chronic bronchitis and emphysema play, too, a large part in its production. The pronounced condition is easy to recognize by the accentuation of the second pulmonary sound, the increase of cardiac dullness to the right, by epigastric pulsation, and by a systolic murmur over the tricuspid area. Under increased demands compensation fails, so that congestion of the liver, kidneys or extremities, and later phlebitis and venous thrombosis appear. There may be cyanosis of the visible mucous membranes, or asthmatical attacks on account of the respiratory deficiency.

Gastro-intestinal Symptoms.

Obstinate loss of appetite is not a constant symptom, but appears very frequently and often quite early, so that even a careful observer may give the stomach his whole attention and overlook the commencing lung trouble. A bad eater is already predisposed to phthisis. The loss of appetite may be enhanced by an aversion to every suitable form of food, especially meat, eggs and milk. This early anorexia is of a toxic nature, the secretory and motor functions of the stomach being usually quite normal; many authors find a moderate percentage increase of hydrochloric acid, others a deficiency of it. We have no information as to which of these conditions is the more frequent or important; and too little attention has been paid to the influence of the severity of the disease, or the existence of fever.

As the disease progresses, to the anorexia there are added indigestion, gastric pain, sensations of fulness, nausea and irritability of the stomach. Generally these are due to a merely nervous dyspepsia. In other cases, especially with progressive disease, more serious stomach disturbances with anatomical changes develop and accelerate the loss of strength. Among the prejudicial causes which play a part in their production are dental caries, so common in tubercular patients, unsuitable and too much food, and the habit of swallowing the sputum.

A very troublesome symptom is frequent vomiting, induced by severe cough; it occurs at first with a full stomach, and during the morning emptying of the lungs. Connected with it is the so-called stomach-cough, which not seldom comes on during meal-times. Its causation is not sufficiently clear; Cornet ascribes it to hyperæsthesia of the mucous membrane of the stomach.

The functions of the bowel are usually normal, and may remain so even in the last stages of the disease; not infrequently, however, there may be more or less obstinate constipation.

In advanced cases toxic diarrhoea often makes its appearance; it usually comes on periodically and alternates with constipation. In rare cases this gives rise to a blood intoxication; but toxic absorption through the intestinal wall is usually the direct result of habitually swallowing abundant sputum. Even if it is only due to a reflex condition of augmented peristalsis, or to catarrhal or other superficial lesions of the mucous membrane, diarrhoea must always be considered as a serious complication, with extremely debilitating effects. Danger from fresh sapping of the strength of the patient is equally to be feared from the specific and non-specific pathological changes of the intestine, which will be referred to later.

Urinary Organs.

Phosphaturia has been described as an important early symptom, but its connection with tuberculosis is not close; it is an evidence of an anomaly of nutrition and is also met with in many other diseases. Intermittent albuminuria, in connection with phosphaturia and highly toxic urine, especially in young individuals with an hereditary tendency, is considered by the French school as a prodromal symptom. The value of this group of symptoms is not yet fully determined; in spite of Maragliano, Teissier, and others, the existence of a specific toxin in the urine is not generally accepted.

The supposed frequent occurrence of constant albuminuria in the initial stage of tuberculosis has also been considered as an early symptom; a similar claim is also made for albumosuria, which also is not more constantly found in tuberculosis than in other chronic septic and febrile diseases. On the other hand orthocatic albuminuria seems to be of some value as an early diagnostic sign, an opinion previously advanced by Poncet. Lüdke and Sturm found albuminuria in a large percentage of tubercular patients with healthy kidneys after standing for one hour, and they consider this to be due to irritation of the kidney by a toxin derived from the tubercular foci. The correctness of their view is shown by the fact that nearly half of those patients who presented no albuminuria after standing gave a positive result on repeating the standing after a small tuberculin injection, not sufficient to raise the temperature.

The presence of indican in the urine of children has equally small diagnostic value.

The diazo reaction has some importance, particularly in relation to prognosis. In early cases it may appear temporarily without serious meaning; in more severe cases it is often absent; if, however, it is constantly strongly positive it indicates, with few exceptions, that the disease will be steadily progressive.

Wasting.

Mention has necessarily been made in the above brief sketches of the various implications of different organs of tissue wasting, which in the first place affects the fatty tissue. In many cases a striking loss of weight is the first sign pointing to serious disease. The loss of weight varies very much as to its time of appearance and intensity; sometimes slow and steady, sometimes rapid, sometimes with alternating periods of loss and gain. Many causes have already been mentioned, loss of appetite, insufficient food, digestive troubles, vomiting, diarrhoea, hæmorrhage, excessive expectoration, profuse sweats, toxic absorption, and fever.

The tissue loss is not confined to the subcutaneous fat, but affects also the muscles, which undergo atrophy and fatty degeneration. A characteristic phenomenon, which has been incorrectly described as distinctive, is fibrillary muscular contraction, easily obtained by percussing the pectoral muscles. The muscles in general often show an increased excitability to direct mechanical stimulation, especially, according to recent observations, the muscles covering the affected part of the lung. Fischer has lately studied the condition of the thoracic muscles, and has come to the following conclusions: the muscles of the region over the tubercular foci in recent cases are paralytic, as is early shown by the results of mechanical irritation; this increased irritability is dependent on a commencing degeneration of the muscles, and must be due to the tubercular toxin. The theory of Pottenger, which is described later, on muscle spasm and muscle degeneration is very similar.

The want of nutrition is also seen in the skin, which becomes loose and wrinkled, and presents a faded grey colour. The glands degenerate, so that the skin is dry, lustreless, and rough. Pigment spots appear, and mycotic fungi develop easily. The atrophy affects the growth of the hair and nails. It is noticeable that the skin secretes an excessive amount of sebaceous material, and becomes smooth and greasy to the touch. It is supposed that this may be explained in these cases by a fatty degeneration of the liver and a fatty infiltration of the sebaceous glands (Jessen).

The Nervous System.

Manifold alterations of the general nervous system may show themselves in different ways. A very frequent symptom, and of value as appearing early, is vaso-motor changes; sudden rushes of blood to the head, rapid changes of colour, quick perspirations—the hands and even the whole upper part of the body being instantaneously bathed in sweat. Here also may be mentioned

the frequent rapid perspirations in the armpits, causing the sweat to run down the body in large drops.

Hyperæsthesia of the skin over the affected lung areas has already been mentioned.

Sometimes there is neuralgia of the intercostal, phrenic, trigeminal, or sciatic nerve, either as a result of toxic infection, or from pressure of large lymphatic glands on the nerve trunk. Irritation of the sympathetic by involvement in contraction of the apex of the lung or by pressure of enlarged glands may cause inequality of the pupil. French authors have particularly studied these phenomena, and recognize them as early symptoms which may precede for several years the manifest symptoms of the disease.

Toxic absorption may induce neuritis, degenerative changes in the peripheral nerves, which are the commonest cause for the appearance in various parts of the body of hyperæsthesia, paresthesia, anæsthesia, and analgesia. Frequently the tendon reflexes are exaggerated. In rare cases deficiency of vision, or hardness of hearing progressing to deafness, may be met with; of which similar essential degenerative nerve changes are the cause.

The central nervous system may also be affected by anæmia, hyperæmia, inflammation, toxic infection, or direct tubercular changes, as will be mentioned later; however, in general, the mental functions remain unaltered.

It may be mentioned that the psychology of tubercular patients may undergo many alterations, according to the kind or duration of the disease. This reaction has individual differences according to the age, sex, constitution, education, character and knowledge of life. One can recognize in phthisical patients in general a great changeability of mood, weakness of will power, frivolity, defective judgment, optimism and over-estimation of their physical powers. Cornet says with reason that the phthisical patient is in great part only the product of his circumstances and surroundings, and that the changes in his mental processes are brought about by the manifold and long-continued changes in the organs induced by chronic disease, which ultimately can be traced back to the absorption of tubercular bacterial toxins.

Progress of the Disease.

The large number and extreme multiformity of the symptoms which have been described will account for the various courses taken by pulmonary tuberculosis. These depend chiefly on the kind and intensity of the primary infection, the virulence of the organisms, and the way in which the extension of the tubercular processes

takes place. The wide anatomical differences in the morbid processes best explain the great variations in the clinical progress of the disease. The infection may remain local or circulate without producing manifest signs; after lasting for years in the form of chronic phthisis it may, in spite of transitory or repeated relapses, result in permanent healing; it may in the pneumonic form cause periods of serious illness, lasting for a longer or shorter time and alternating with relatively tranquil intervals, after which healing of the lesion may even take place; or it may lastly in a few weeks or months end in rapid or even sudden death from extensive destructive processes. Moreover, there are numerous possibilities and complications which may cause the progress of the disease to vary in countless ways.

As a rule pulmonary tuberculosis begins slowly and insidiously, hiding at first its true character. It often reveals itself first not through the respiratory organs; but if respiratory symptoms are present the suspicion of phthisis is soon roused. A dry cough appears, which is ascribed to a cold, but lasts longer than usual. It is followed by a little expectoration, which also at first does not attract attention. Aches, stabbing pains, and feelings of oppression, which may or may not be localized in a fixed spot, then follow; not infrequently quite early there may be a noticeable shortness of breath, especially on exertion.

In other cases several of the before-mentioned toxic symptoms may be most prominent, or they may accompany the lung symptoms. An obstinate loss of appetite is to be noticed, or without this being particularly bad an exceptional loss of weight, with anemia, exhaustion, tendency to fatigue, great need of sleep, throbbing in the head, and vaso-motor changes. The symptoms often resemble those of chlorosis, especially if those connected with the respiratory organs are absent; so much so that treatment may actually be directed to that complaint for some time. Or indigestion with loss of appetite and weight may be the prominent symptoms, so that the attention may be directed to the supposed gastric catarrh, as has been already mentioned. Often, too, feverish symptoms, such as shivering, flushed cheeks after meals, or in the evening, or irregular night sweats, may claim notice rather than the pulmonary condition.

Fairly often an initial hæmoptysis is the first sure sign of phthisis that brings the patient to the doctor. Most patients have had many of the above-mentioned symptoms for a longer or shorter time without noticing them; but it is not rare for a hæmorrhage due to latent tuberculosis to come entirely as a surprise to a person in good health.

**Chronic Indurative
Forms.**

The slow, gradual onset (that was described) corresponds generally to a chronic indurative process, beginning in the apex of the lung, of relatively favourable prognosis. Under proper treatment, a suitable mode of life, and good hygienic surroundings the disease is soon arrested, the symptoms disappear more or less quickly, the strength increases, and the general condition becomes normal again. The objective signs in the lung remain stationary or improve gradually, often only after long months of unsatisfactory examinations. The result may be complete healing with cicatricial contraction of the lung and drawing in of the upper part of the thorax. In other cases, even after many months of subjective well-being, the disease being apparently at a standstill, the tubercular process may commence to progress steadily and lead to a fatal issue, usually from gradual exhaustion.

**Pneumonic
Forms.**

In contradistinction to these chronic varieties we have the pneumonic form of tuberculosis, with its sudden onset and rapid course. The disease begins acutely in the guise of pneumonia, for which at first it may be mistaken; or an acute aggravation occurs of a disease which has been recognized for a shorter or longer time. The site of the lobar infiltration is more often the lower lobe than the upper. The expected resolution of the supposed genuine pneumonia is deferred, the fever is not resolved either by crisis or lysis, the expectoration becomes more copious, and the patient sinks visibly; this is the rapidly fatal florid phthisis. Anatomically one finds by the side of more or less extensive old tubercular infiltration a caseous hepatization, with commencing cavity formation at one or more points. The pneumonia in these cases is generally produced by aspiration of caseous debris, and is not infrequently observed in connection with a severe hæmoptysis.

**Transitional
Forms.**

Between these two extreme types there are many forms of commencement and course of an intermediate character. Cases resembling the pneumonic form do not always have a fatal ending, but under some circumstances may even undergo slow re-absorption. This occurs in the rare cases in which there has been aspiration of only slightly infectious material. After a long illness there may be *restitutio ad integrum*, and the process takes its course through other pathological changes. Here and there it may happen that only a few fucilli develop, so that an isolated caseous nodule is formed, which may suffer the usual fate of other caseous nodules, either connective

tissue encapulation, calcification, or softening, and excavation. This may form the starting point of infection for a secondary lobar diplococcal pneumonia or of a lobular influenza pneumonia.

Lung

Contraction.

A frequent clinical type is that of unilateral contraction of the lung, which represents fibroid phthisis in the proper sense. Anatomically considered, there is usually a well marked, connective tissue, cicatricial contraction in the upper part of the lung with bronchiectasis; the thoracic wall is affected by the shrinking process, and is usually markedly drawn in. Cavities also occur. The process of contraction involves neighbouring organs: the spine presents a lateral curvature, the heart is much displaced, and the right ventricle hypertrophied, the diaphragm is drawn up, and the healthy lung becomes more or less emphysematous. These changes indicate a relatively favourable ending to a slowly developed, severe, excavated phthisis. The general health of the patient is but little affected, the nutrition is generally good, the cough and expectoration are small in amount unless otherwise increased, fever is absent or only occasionally slightly raised, shortness of breath is insignificant, usually slight cyanosis is present. Nevertheless, these patients are in constant danger of becoming worse, especially from spread of infective material through the bronchi from the cavities; yet frequently they may remain in this state for many years, if they take care of themselves and if they continue free from complications.

So very various are the atypical anatomical changes, such as limited fibrous tubercular nodules, insular or lobular caseous processes, which may be in any form of cavity formation, changes which may occur successively or be present side by side, or which again may be greatly altered by secondary inflammatory processes, that it is impossible to give an exhaustive clinical description of the course the disease may follow. The end of most cases of advanced disease is death, brought about by general exhaustion, increasing suffocation, or heart failure. Complications also play an important part in producing a fatal issue, as is sufficiently described in the account of tuberculosis of the individual organs.

3. DIAGNOSIS.

The modern methods of diagnosing pulmonary tuberculosis consist of a series of component parts, corresponding with the various epochs in the history of medicine. The important symptoms just described, recognized as the result of empiricism and

of careful observation of the patient, serve for the making of an empirical diagnosis, familiar to the physicians of the classical ages. The discovery of percussion by Auenbrugger and of auscultation by Laennec laid the foundations for the method of physical diagnosis, which by the middle of the nineteenth century in all essentials had already attained the same perfection as it has to-day. The discovery of the tubercle bacillus opened the era of bacteriological diagnosis, which naturally for some time completely governed the clinical study of tuberculosis, without maturing into essential progress towards the full understanding of the disease. This was reserved for the discovery of the tuberculin, which especially inaugurated the era of early diagnosis of tuberculosis, and placed on a firmer basis the problem of combating tuberculosis as a racial disease. Our knowledge on these subjects has been greatly advanced by means of the use of tuberculin for diagnosis. With it ranks in value the great discovery of the diagnosis by Röntgen-rays in the living patient. Other methods of early diagnoses, which in part have only reached the importance of interesting biological phenomena occurring in the tubercular organism, have lately acquired a certain value; such are the observations on the agglutinative property, the opsonic index, complemental deviation, anaphylaxis, lymphocyte spurtum, and the neutrophil blood-count of Arneth.

This short review of our diagnostic methods in their historical order will give an idea of their number. They will now be separately considered, regard being paid to their practical importance, so that but brief attention will be given to those methods whose value is still more or less doubtful, or which on account of the expense or time involved are hardly suitable for medical practice.

I. The History of the Patient.

Careful consideration of the previous history of the patient has, for the diagnosis of phthisis, an importance which must not be under-estimated. A so-called positive history is not only of determining value in cases of doubtful diagnosis, but by affording an accurate idea of the mode of onset of the disease may give valuable information as to prognosis.

In the pronounced forms of manifest tuberculosis the history of the patient may appear superfluous, but for early diagnosis it is indispensable. If, for example, it is a question of very early disease of the apex, of mischief in an unusual site, of difficulty in differential diagnosis from diseases closely simulating pulmonary tuberculosis, or of suspicious general symptoms existing with doubtful objective signs, then the history of the patient

may place the diagnosis on a surer basis, if it is elicited in a way suitable to the individuality and intelligence of the patient. The details of the history will afford an insight into all those predisposing causes mentioned in the section on predisposition. From the history we seek to ascertain under what particular circumstances and in what way the disease originated; we must follow the source of infection in the family, examining closely into the question of an hereditary tendency, and, if the infection is to be sought outside the family, we must endeavour to ascertain whence and how it occurred. If we succeed in obtaining a possibly complete explanation of the infection, and the internal and external conditions accompanying the development of the disease, it will be not only of scientific importance for adding to the knowledge of the aetiological causes in single cases, but will also give many indications for prophylaxis and treatment.

A careful consideration and critical examination of the data supplied by the history, taken in conjunction with the results of clinical examination, will also make a prognostic opinion on the case possible; and will make it easier to determine whether we have to do with a healing, stationary, or progressive disease. The determination whether a case of phthisis is only developing slowly in spite of a hard occupation, unhygienic surroundings, or other unfavourable influences, or whether it is showing a great tendency to active advance in spite of an easy life, care, and suitable treatment, whether loss of weight is absent or insignificant, occurring gradually, or suddenly and quickly, are very noteworthy points in the history of individual cases for the purpose of foretelling the course the disease will take. The necessity of extending the diagnosis on its prognostic side not only frequently affects the private practitioner in relation to patients of all classes of life, but is a constantly recurring problem in all cases of pulmonary tuberculosis affected by compulsory insurance.

II. Physical Diagnosis.

Inspection.

Inspection includes the consideration of the general appearance of the patient, for which at least the upper part of the body must be completely undressed. Particular attention must be given to the constitution, the state of nutrition, the muscles, the subcutaneous fat, the skin, the colour, the carriage of the body, and expression. In many cases that general appearance can be recognized which the older writers well designated the phthisical aspect. Its essential characteristics are: a slender stature, slightly stooping carriage, poorly developed muscles, scanty adipose tissue, pale skin with venules

showing through, red hectic flush, long hair, a lengthy, narrow, flat thorax, small thin hands, and a tired expression, the peculiar, moist, glittering eyes being very noticeable. These signs, to which may be added a striking irritability of the vasomotor system, are not always to be found in their entirety, but make up between them the phthisical aspect.

Particular importance has been attached from antiquity to the paralytic thorax. It is a long, narrow, flat chest with narrow intercostal spaces, an acute epigastric angle, sloping shoulders, and wing-like projecting shoulder blades. With this the clavicular hollows are flattened, and the jugular vein sinks in; the acromial end of the clavicle is lower and comes more forward; the antero-posterior diameter of the thorax is shortened, and the circumference of the chest is deficient; the sternal angle is small, or the sternum may be flat or even sometimes bent inwards.

Rothschild denotes by the sternal angle, which has been quite wrongly called the *angulus Loderici*, the "pyriform excrescence" of the sternal angle, which in phthisical patients indicates a premature ossification, and is of itself a pathognomonic sign of a predisposition to tubercular infection." It cannot be denied that the premature ossification of the cartilage between the manubrium and sternum will be injurious in the same way as ossification of the first rib cartilages, but it occurs relatively much too rarely to be considered of the importance for the predisposition to phthisis that Rothschild estimates it. More recent examination of this subject by A. Hofmann, Ehrlein, and others, also supports the latter view. Moreover, it is incorrect to consider the prominence of the sternal angle as an excrescence.

The paralytic thorax is no doubt a common concomitant of phthisis; it is, however, absent in the majority of cases, and is also often met with without the existence of phthises.

Of great diagnostic value are local flattenings or depressions; so also are partial limitation of the respiratory movement, and slight expansion and delayed movement of the diseased areas, especially over the upper part, but which from disease in the lower lobe or pleura may occur over the whole side. The flattenings or depressions may be on one or both sides, in the latter case usually more marked on one side; in most cases they accompany chronic fibroid processes, and they are especially indicative of the amount of contraction in the underlying lung.

A unilateral drawing-in of the apex of the lung is especially a sign of tubercular disease.

Mention must be made of a peculiar muscular atrophy, which cannot be explained as a wasting from disuse. A toxic influence has also been adduced as the cause, but this could not account for a partial atrophy in a single muscle. Jessen explains the limited atrophy as the result of nerve change, and leaves it

undecided whether this is a latent morbid or a purely functional change. New light has been thrown on this subject by the theory of Pottenger, which will be considered in the section on palpation.

Dropping of the acromial end of the clavicle, which normally stands slightly higher than the sternal end, is characteristic (*Aufrechten*); so also is lagging behind of the acromion on deep inspiration (*Kuthy*).

While retraction is usually only met in late cases of fibroid phthisis, and is associated with a small expansion, the delayed respiratory movement usually occurs in quite an early stage, and is therefore of importance as an early symptom. The side that lags behind may reach the maximum movement of normal inspiration, but later than the other side, or may remain deficient in movement. With progressing lung contraction the delayed movement usually disappears, while the flattening remains.

Bilateral disease causes the respiratory movement to be different on the two sides, and indeed markedly so, since the delayed movement affects the newly implicated side, while on the side of the old disease the expansion is limited on account of cicatricial contractions. These changes occur in suitable cases with such regularity that the diagnosis cannot infrequently be made from them alone. Sometimes crossed delay of movement is found (*Turban*), for example, with infiltration of one apex and pleurisy of the opposite side.

These phenomena can be best observed if one sits in front of a standing patient or stands behind one sitting, so that the thoracic movements of both sides can be observed and compared more in profile.

The degree of partial thoracic retraction, or of extensive thoracic shrinking, indicates the amount of contraction of the lung tissues; here it is especially the elasticity of the chest wall, dependent on the age of the patient, which turns the scale. The greatest retraction accompanies one-sided contraction of the lung with pleural adhesions; when there is often also displacement of the neighbouring organs which can be detected by inspection, e.g., cardiac displacement, or curvature of the spine.

Sometimes emphysematous pads appear above the clavicle, which are the visible signs of a vicarious emphysema surrounding a central area of contraction; however they do not in any way exclude the existence of active processes.

Litten's diaphragmatic sign* is another condition helpful for

* This consists of a visible wave 2½ in. to 3½ in. in altitude, due to the respiratory movements of the diaphragm, the patient being placed in a certain position in a good light. The breathing must be of maximal depth, and there must not be too much fat.

diagnoses in suitable cases. It fails in the presence of extensive pleural adhesions and of fluid or air in the pleural cavity. Unilateral diminution of the diaphragmatic movement is due to disease of the lung or the pleura. It depends on certain parts of the lung being cut off from respiration, or hindered in their function. This unilateral limitation of the diaphragmatic movement is important as an early symptom of slight, initial, apical disease; in conditions of apical induration its presence is, according to Krümg, in favour of a tubercular origin. It is most commonly caused by adhesion of the pleural surfaces. As further causes, reflex action through the respiratory nerves and injury of the phrenic nerve by pleuritic adhesions at the lung apices, or by pressure of enlarged tubercular glands, have been mentioned.

On inspection of the skin one can often recognize enlarged venules on the anterior wall of the chest, or enlarged stellate capillaries, especially at the upper aperture of the thorax before and behind, and more frequently still along the lower margin of the ribs. They are due to chronic venous engorgement of the internal mammary and intercostal veins on account of stasis in the axillary vein. They, as well as the enlarged temporal vein mentioned by Sirakoff, are observed in connection with phthisis, especially in association with enlarged lymphatic glands.

There are often various symptoms connected with pulmonary tuberculosis which can also be detected by inspection; a red or bluish line on the gums, the frequently mentioned inequality of the pupils, the common occurrence of a high, angular palate, lowering of the nipple on the affected side in men, atrophy of the breasts, and diminution of the pigment in the usually small areolæ of the nipples. In cases of thoracic contraction the atrophy of the breast is sometimes only apparent.

We may pass over other still more indefinite symptoms connected with the stigmata of degeneration of the tubercular predisposition.

Palpation.

Palpation completes and augments the results of inspection. The delay of movement and the deficiency of expansion can be well estimated by palpation, if for any reason, as poor illumination, inspection is not sufficient. Goldscheider recommends that a lagging behind of the first ribs, which can nearly always be felt, should be sought for. By palpation we may also detect a great resistance of the infiltrated parietes.

With disease of the upper part of the lung the overlying muscles of the neck and thorax may be felt, best with the lightest palpation, to be more rigid and tense than those of the sound

side. These spastic contractions, which may be also visible, are, according to Pottenger, a special sign of fresh active disease, and are caused by reflex irritation emanating from the lung or pleura, conveyed by the sympathetic spinal cord and motor nerves to the muscles. This segmental irritation of the spinal cord probably affects the motor nerves in the same way as Head has shown for the sensory nerves (Head's zones). In chronic processes the muscles will lose their elasticity and undergo a pulpy change in consequence of secondary degeneration processes.

Pottenger employs the observation of the muscle changes in the neck and throat for the diagnosis of disease of the lung and pleura, and lays special stress on the state of the muscles in forming a differential diagnosis between active and inactive disease.

He ingeniously explains the delayed movement and rattling of the chest-wall as the result of muscle spasm and degeneration of the contracted muscle, and sees also in the abnormalities of the upper aperture of the thorax, the rounded shoulders and deformities of the chest, the final results of muscular changes.

His observations have taught us that muscular changes are best detected by light palpation. From further observations he concludes that by this method of touch not only can the normal organs of the chest and abdomen be worked out from each other, but that it is possible to diagnose certain diseases of these organs by changes in their consistency.

These new methods of very light palpation have hardly yet received confirmation in Germany, but they resemble the method of estimating resistance by touch and Klumpke's tactile percussion, and deserve further trial as they tend to the refinement of diagnostic methods.

In this connection reference must still be made to the increased irritability to mechanical and electrical stimuli of the thoracic muscles over the diseased areas.

Palpation is also of service for the examination of vocal fremitus. A distinction can be drawn between the subjective vocal fremitus, which can often be detected by the patient himself, and the objective fremitus as observed by the examining hand. It varies much over tubercular deposits and affections of the pleura according to the power of elasticity and resonance of the tissues. The vocal fremitus is usually increased over fibroid indurations, over infiltrations, over cavities lying near the surface, over dense well-conducting pleural thickenings, and over the compressed lung above a pleural exudation. It is diminished or quite obliterated by an effusion of serum, air, or pus into the pleural space, or by blocking or compression of a bronchus by secretion, or enlarged glands, &c. In fat and very feeble persons the detection of vocal fremitus is difficult. It is more easily felt manually on the right side, especially in the upper posterior region, on account of the greater size of the right bronchus.

By pressing or tapping over the upper part of the chest we can elicit not uncommonly a tenderness over the affected part of the lung, on account of the inflammatory irritation of the apical pleura; this sensibility can most often in early disease be detected in the supraspinous fossa. Another area which is often tender on pressure is the interscapular region, and the spinous processes of the upper thoracic vertebrae; it is associated with tuberculosis of the intrathoracic glands. Strong percussion will bring out these tender areas more easily than palpation.

By palpation can be also observed a narrowing of the intercostal spaces in contraction of the chest wall. In retraction of the lung there is a broadening and augmentation of the heart's impulse, which can be best and earliest detected as a pulsation of pulmonary artery.

Moreover by palpation we must obtain information about the lymphatic glands, so often the site of tubercular disease. Very frequently the lymphatics of the neck are infiltrated, but the anatomical and pathological connection between these supra-clavicular glands and the deeper cervical lymphatic chain is not yet sufficiently determined. Recently v. Lebrowski has drawn attention to the subcutaneous thoracic lymph glands, but they may be palpable in non-tubercular lung processes, and not so in tubercular disease.

In about 20 per cent. of the cases of pulmonary tuberculosis the lymphatic glands lying in the mid-axillary line in the fourth and fifth spaces are enlarged. The enlargement of this lower group of lateral thoracic glands is in consequence of specific changes, due to passing out of bacilli from glands in the interior of the chest. These glands may serve to direct attention to lung apices, and in doubtful cases may assist the diagnosis. In individuals free from lung disease v. Lebrowski found these glands enlarged in only 2.5 per cent. of the cases.

Since these glands are also enlarged in acute, inflammatory, non-tubercular processes (pneumonia), in doubtful cases the suggestion of Schürze to remove a small gland for microscopical examination or inoculation may be followed.

Turban draws attention to a slight swelling of the thyroid gland as one of the earliest symptoms of tuberculosis, more seldom seen in later cases. This enlargement of the thyroid is especially seen in young women, and may reach such a grade that, in conjunction with the tachycardia frequently present in tuberculosis, it may lead to an erroneous diagnosis of exophthalmic goitre in cases of early or latent phthisis. We must, however, not forget that many French authors, and also some German, consider tuberculosis as a cause of Graves's disease.

**Chest
Measurements.**

The circumference of the chest must be taken with the arms horizontal in the respiratory pause; in men, just below the shoulder-blades and nipples; in women, above the breasts. It should, in normally-developed men, measure at least half of the height; if it is less the thorax is weak and predisposed to phthisis.

Of importance for the function of the lungs is the respiratory expansion, the difference between the chest circumference on expiration and on deep inspiration, which should not be less than 2 in. An increase of the expansion during treatment is at least an objective sign of an improvement in the respiratory mechanism.

The combined measurements of the body-weight, height, chest circumference and respiratory expansion give a good idea of the general condition and of the development of the thorax; by means of calipers the length, breadth and depth of the thorax can be easily and quickly added. Similar measurements of both halves of the thorax, to estimate, for example, the amount of retraction of the chest after pleurisy, can be suitably made with a thin lead pipe or a cyrtometer.

Spirometry.

v. Ziemszen utilizes the relation between the vital capacity of the lung and the height, first observed by Hutchinson, as a means of distinguishing normal and subnormal respiratory powers. In normal men he takes the lowest proportion to be 1 cm. of height to 20 c.c. vital capacity; in normal women, 1 to 17. If the proportion falls below this v. Ziemszen considers that there is a considerable disturbance of the respiratory organs; an important fact, the truth of which was confirmed for phthisis by Tarhon, and which we also can support from the examination of a large number of cases. Further, we can state, as the result of reliable spirometric measurements taken at the same time of day, that a continued diminution of the vital capacity indicates advancing tubercular disease, while an increasing capacity indicates an improvement in the general lung condition. This increase does not merely mean an augmentation of the respiratory surface from opening up of infiltrated areas, but also is a most important indication that the whole respiratory apparatus is in better order.

Percussion.

Only the most important points for the diagnosis of pulmonary tuberculosis need be referred to in connection with the method and technique of percussion. Which method of percussion is preferred is a matter of practice and custom. We, like other observers, use by choice either the finger or the pleximeter. In both methods the feeling

of resistance is communicated to the percussing finger in the same way; both methods also allow of the tactile percussion recommended by Ehlstein and Turban, that is, estimation of the tactile sensation received on giving short percussion taps with a stiff wrist. The percussion note is always to be compared over the two lungs in corresponding places and with equally strong taps.

Of course the comparison of symmetrical notes does not alone determine the existence and amount of diminution of the note or dullness. The comparative percussion of symmetrical spots permits the contrasting of the altered lung note with the normal sound which is absolutely necessary in order to appreciate the fine grades of difference between loss of resonance and absolute dullness.

It is clear that comparative percussion in symmetrical spots does not produce a normal lung note of constant pitch and resonance, but that it must be different in every individual, since it arises from the vibrations of the chest wall and thoracic organs—two variable factors. The correctness of this interpretation has recently been further confirmed by the experiments of Moritz and Rold.

Percussion is practised from above downwards, first in front, then at the back. In each intercostal space the median and lateral parts are to be compared with each other. For the percussion of the back the arms are to be crossed over each other, so as to draw the shoulder-blades as far as possible apart. It is important that the head be kept quite in the middle line, and that the muscles of the thorax, especially the shoulder muscles, be completely relaxed; therefore the patient must assume an easy attitude and must not throw out the chest. Every part of the thorax is to be percussed, and the axillæ especially, if the result of percussion at the apices is doubtful. Behind, the interscapular region is especially to be examined; deficient resonance here indicates changes in the hilus, which are much more frequently met with in tuberculosis than was previously thought. In estimating the lower limits of the lung one pays attention to their powers of expansion on deep inspiration. This is the more important as a unilateral deficiency of expansion with a flattening of the note not uncommonly points to an affection of the pleura.

The thickness of the overlying soft parts must be considered; so that percussion behind must be rather firmer than in front. The best results are afforded by the lightest percussion that just gives a perceptible sound. The pleximeter or finger must be carefully kept parallel to the edge of the lung, especially in marking out its lower border. For purposes of control and in doubtful cases the tactile percussion of Ehlstein is useful. Usually the patient should only breathe gently, but if the results are uncertain a deep inspiration will sometimes bring out the difference of note. If the note is only slightly changed in the upper part of both

lungs, so that its estimation is difficult, then it is best to percuss upwards from the lower part of the lung with normal note towards the apex. The method of v. Strümpell can also be employed.

As tubercular disease usually begins in the apex of the lung it is by the careful examination of this part that an early diagnosis is chiefly to be made. Percussion naturally fails to detect very slight early changes; a distinct diminution of the amount of air contained is required to produce a difference in note. From lowering of the tension the note often acquires a tympanic character. In unilateral apical disease percussion of the clavicles will often determine the affected side. The first rib lies in close relationship to the lung apex, so that, according to Plesch, we may obtain the resonance of the whole extent of the apex by percussing over the manubrium sterni, a hand being laid on the other apex to exclude its vibrations. It is often useful to stand a patient against a door while percussing; it will then be more easy to obtain apical dullness as the background is resonant (Goldscheider, Wenzel). With alteration of the note on both sides it may be very difficult to determine which side is affected; auscultation here comes to our aid. In more advanced changes not only can the infiltration be detected, but also the contraction of the lung by lowering of the apex; it is then that marking out the upper lung limit is of special value.

Very good results accrue from mapping out Krönig's band of resonance. The upper limit of the lung apex is not determined, but the lateral borders of the apical resonance are projected as a broad, vertical band above the shoulder girdle by the lightest percussion passing from within outwards before and behind. While healthy lung apices give the same clear note over equally broad areas, if there is even quite slight infiltration and retraction an easily measurable diminution of the resonant area will be detected.

Goldscheider employs another method for mapping out the upper limit of the lung. He rightly raises the objection that the real lung apices, especially their highest points, are not marked out at all by Krönig's method, that his band of resonance is only the projection of one and the same point of the apex in different directions, and that the lateral limits are thoroughly unreliable, since not the apices, but the part of the lung underlying the third and fourth ribs is percussed tangentially. To be able to mark out the absolute lung apices it is necessary to be quite clear about their topographical anatomy, as shown in Goldscheider's diagram (fig. 3).

We see that in the supra-clavicular region there are three parts of the lung concerned, which are not of equal value for

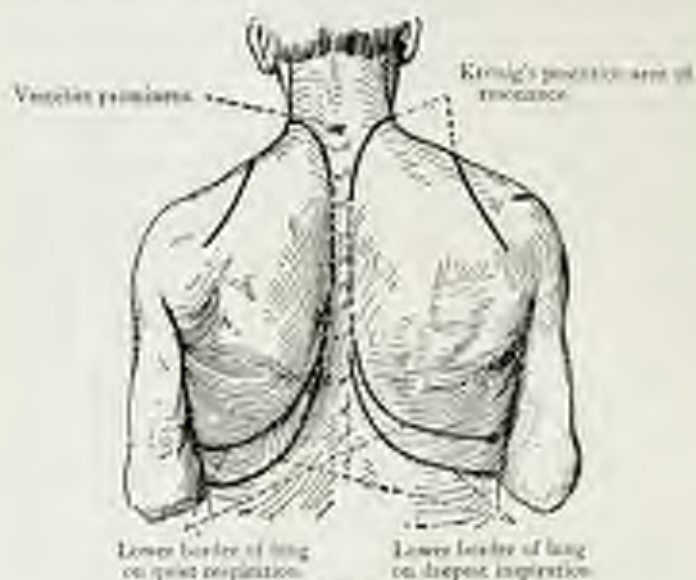


FIG. 1.

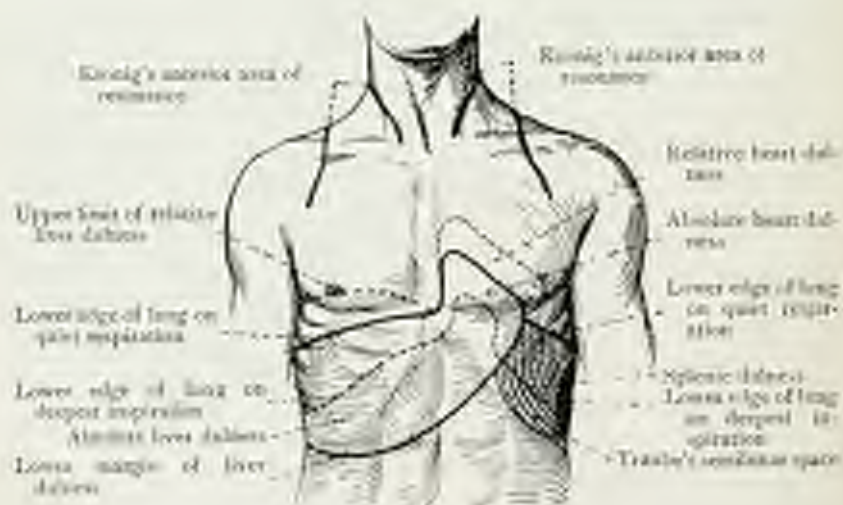


FIG. 2.

Figs. 1 and 2 after Kernig, "Deutsche Klinik," Bd. 11.

percussion: (1) The true apical portion, which projects from the aperture of the first rib and is largely covered by the sternum-

mastoid muscle; (2) the portion of the lung covered by the first rib; (3) a smaller part between the first and second rib, belonging to the first intercostal space. The two latter comprise the sub-apical part of the lung. The highest point of the apex corresponds to the neck of the first rib, marked behind by the projection of the spinous process of the first dorsal vertebra. Therefore, in front the apex of the lung occupies only the inner part of supra-clavicular fossa; and, behind, only a small median part of the supra-spinous fossa comes into relation with the lung. This is of importance as the whole of the supra-clavicular and supra-spinous fossae are still identified with the lung apex. The actual margin of the lung apex may be defined by very light sagittal



FIG. 3.

Topography of the apex of the lung after Goldscheider. —Upper and medial margins of the lung. Outline of the first rib and clavicle. On the left side the clavicular head of the sternomastoid muscle is removed, so that the scapular notch is seen. The upper limit of the lung lies a little above the inner edge of the first rib tubercle.

1.—Apical part. 2 and 3.—Sub-apical part.

percussion with the use of Goldscheider's glass pencil or Plossch's finger movement. In the latter method the finger that is struck on the second inter-phalangeal joint is bent at right angles at the first inter-phalangeal joint, while the other fingers are held with the palmar surface parallel to the percussed area without touching it.

Goldscheider now employs a special method of percussion, that is, one so light that a scarcely perceptible sound is produced.

This method of very gentle percussion is quite on the principle of Weil, but was first employed by Ewald for the delineation of the relative heart and liver dulness, and is founded on the law of Ferhner for the appreciation of differences of sensation.

After the whole of the apices of the lungs have been marked out in front in the usual way, percussion must then be made, with the patient in a sitting position, between the heads of the sternomastoid muscle, comparing both sides from below upwards, and estimating the height of the upper margin of the lung and its distance from the upper border of the clavicle. Percussion of the mesial border of the apex succeeds the best when the head is turned to the opposite side without putting the sternomastoid muscle on the stretch. Afterwards the first rib is percussed from its tubercle to the most internal point that can be reached, also the clavicle in the neighbourhood of the sternoclavicular joint. It is superfluous to percuss out the external lateral edge of the apex. To uncover the first intercostal space from the clavicle the shoulder must be drawn up and back as far as possible. By strong upward movement of the shoulders percussion can be carried to the highest points of the armpits, and often gives the most exact results.

Percussion of the lung apices behind with the lightest finger-to-finger movement, the shoulder-blades being drawn as far as possible outwards and forwards, shows that the resonance begins close to the vertebral column at the level of the spinous process of the first thoracic vertebra, exactly where Goldscheider localizes the highest point of the lung. The inner edges of the lungs converge opposite the second thoracic vertebra, and from there downwards lie close to the vertebral column. Goldscheider considers the delineation of the outer margin of the lung apex to be equally valueless behind as in front.

The question whether to give the preference to Krönig's or Goldscheider's methods may be answered as follows: the estimation of the position of the lung apices and of their inner margins by Goldscheider's method is doubtless very possible; but, on the other hand, the technique of Krönig's method is simpler, and gives in practice sufficiently useful results. Both methods should be learnt and employed in exceptionally doubtful cases, so that the results of one method may be controlled by the other; this will also demonstrate the fact that one is very easily deceived in estimating very slight differences of note.

The most frequent sources of error in percussion are inequality of the osseous framework, slight scoliosis, and varying thickness of the shoulder muscles. Therefore most attention for

diagnosis is paid to slight differences of note if they are not accompanied by obvious retraction of the affected side. It must further be remembered that a lower position of the apex is indicative of a contraction and therefore also of healed nodules. On these grounds we consider the comparative percussion of both apices during deep inspiration is required in bilateral alteration of the note; the anatomical changes hinder the entry of air on the affected side in spite of the deep inspiration and the difference in the note is therefore brought out more sharply.

The initial shortening of the note is converted with the increasing infiltration of the lung tissue into dullness, which may be slight and relative, or intense and absolute. The dullness only indicates that the underlying tissue is more or less airless. One must always, according to the localization, think of the existence of enlarged glands, mediastinal tumours, pleural thickening, &c., and seek for means of differential diagnosis.

With advancing infiltration the dullness increases in intensity and extent. From the nature of the disease it is obvious that these changes are not regularly progressive, but may be altered in many ways by re-absorption or destructive changes, by the development of specific or non-specific pneumonic patches, by pleural complications and by emphysema.

In consequence of the diminished tension of the lung tissues the dull percussion note may become tympanic. This tympanic note is heard especially over cavities, over incomplete pneumonic infiltration and above large pleuritic effusions.

The percussion note is affected in various characteristic ways by cavity formation. It is very frequently tympanic or dull tympanic, and presents different kinds of changes in the note of which the following are the most important. Commonest is Wintrich's sign, when the tympanic note is higher with the mouth open and lower with the mouth closed. The respiratory change of Friedreich consists of the tympanic note becoming higher with a deep inspiration, and even disappearing from the respiratory tension on the cavity walls. Gerhardt's sign depends on the fact that alteration of the position of the fluid contents of the cavity changes the pitch of the tympanic note, so that the note usually becomes higher if the patient assumes an erect position. Over smooth-walled cavities of regular shape and sufficient size the percussion note has a metallic sound. Over cavities communicating with an open bronchus by a narrow opening, especially apical cavities, a cracked-pot or coin-clinking sound may be heard.

Percussion also gives information as to the enlargement or

displacements of neighbouring organs, especially of the heart. With contraction of the lung the heart is often dragged to the affected side. But also with the heart in its normal position the absolute heart dulness may be displaced towards the affected side, whilst it is equally diminished on the sound side from emphysematous changes in the unaffected lung compensating for the shrinking (Turban). Even in moderate shrinking of the right apex a displacement of the absolute heart dulness to the right, with or without a displacement of the heart itself, is, according to Turban, of such regular occurrence that he considers it a typical leading feature of long-standing, right-sided, apical disease. This condition must not be considered as a broadening of the heart's dulness to the right. The true outline of the heart can only be ascertained by the lightest percussion or by Erbstein's tactile percussion.

Auscultation.

For the purpose of avoiding extraneous sounds, the position of the patient during auscultation must be the same as that mentioned in the section on percussion. Likewise, each spot of the thorax is to be examined, the axillæ, the anterior inner margins of the lungs and the lingula not being omitted; for the initial processes may develop in an atypical place. Auscultation with the unaided ear is only suitable for the examination of gross lesions over large surfaces; for the recognition of finer signs over small deposits a stethoscope is required. The material and form of this is not indifferent; a wooden one with a large ear-piece and small chest-piece is the best. If the examination room is not sufficiently shut off from disturbing outside noises the non-auscultating ear may be closed in a convenient way, or one may accustom oneself to a binaural stethoscope in one of its forms with india-rubber connections. But with all such instruments one must first learn to eliminate extraneous sounds.

For auscultation the patient must breathe quietly and somewhat deeply through the nose, so that the lungs are uniformly expanded (Turban). In mouth breathing the expiration especially acquires rather an accentuated character, which must be allowed for if nasal obstruction compels its use; the weakened inspiration and prolonged expiration being then deceptive. The stethoscope is placed several times in each intercostal space, in front and behind, according to the size of the chest. Both sides are to be compared at corresponding places, and, of course, both sides may be diseased.

On auscultation we must observe the quality and strength

of the respiratory sounds, and the relation between the inspiratory and expiratory sounds in regard to nature and duration. Of particular importance, as often the first symptom of commencing apical mischief, is a not clear or hoarse vesicular sound, which often has a vibratory character. Its production depends on a soft swelling of the finer air passages (Dettweiler), on small isolated rhonchi, not yet accompanied by secretion, in the bronchioles (Sahli), or on the air in consequence of the existence of small airless nodules entering the alveoli by fits and starts (Turhan).

From the pathological harsh breathing we must separate the physiological breathing accompanied with a sort of humming sound, which is often heard as an unbroken sound during inspiration and the greater part of expiration, becoming louder with inspiration and dying down with expiration. With Walter, we hold these to be muscle sounds, especially due to the contraction of the inspiratory muscles. It is not, however, correct to ascribe, like Walter, well-marked harsh breathing to the same muscular cause and to give it the same pathological meaning.

Cog-wheel breathing is to be explained in the same way as harsh breathing, which, according to Turhan's supposition, is due to quite large lung areas of defective function in the neighbourhood of infiltrations; but it is not to be confused with the systolic cog-wheel breathing caused by the systole of the heart and which is not pathological. Cog-wheel breathing is usually accompanied by exaggerated vesicular breathing, and is in favour of tuberculosis, especially if it is limited to one apex. It may also, with diffuse bronchitis, be a sign of local catarrh, but much more often it is the result of exaggerated respiration near contracting processes or in the neighbourhood of small nodules, and easily assumes a harsh character. Weak vesicular breathing, like harsh breathing, is a sign of early mischief, and they are often met together. Weak breathing over the whole of one side may also be the result of extensive pleural adhesions or of compression or partial blocking of a main bronchus. In more advanced changes it disappears.

With advancing infiltration the breathing becomes more bronchial. As transitional forms Dettweiler recognizes the vesiculo-bronchial breathing, when the vesicular character predominates, and the bronchovesicular when the bronchial character is more marked. Both forms may also be harsh or weak.

We agree with Turhan that minute subdivisions of indefinite breath sounds at the most are only for the convenience of expression and are best excluded from the nomenclature. If the character of the breath sounds is in fact indefinite, then it is interfered with or masked by other sounds.

The respiratory alterations which have hitherto been described affect both inspiration and expiration. In the early alterations of the inspiratory sounds expiration is frequently still unchanged, but gradually it becomes affected, but it, as a rule, becomes markedly bronchial later than inspiration. As soon as the infiltration has become established in the apex it is louder, rougher and more bronchial in character. Prolongation of the expiration is characteristic, and appears with supervention of contraction, and particularly in the presence of emphysema. In tuberculosis of the upper part of the lung, if heard over the lower healthy portion, or over the other lung, it indicates emphysema.

A very important practical point is that expiration may be louder, sharper and more prolonged over the right apex, especially behind, without the lung being affected. This physiological difference from the left side is found approximately in a third of healthy people, and is due to the larger size and straighter course of the right upper bronchus.

The intensity and extent of the bronchial breathing is regulated by the density and size of the infiltration, but it is not usually so widely diffused as in a genuine pneumonia. Expiration is sometimes more intensely bronchial than inspiration. Also condensation or compression, as above a pleural effusion, may produce bronchial breathing. Cavities are also a most common cause of bronchial breathing, if they communicate with a bronchus. Over a cavity the bronchial breathing often takes an amphoric character. Amphoric breathing in conjunction with Wintrich's or Gerhardt's percussion signs is the surest indication of a cavity, especially if it has a metallic quality. The conditions for the production of this phenomenon are the same as for the metallic percussion sound: the cavity must be of regular shape, smooth-walled and comparatively large. Sudden change during inspiration from vesicular to bronchial character, or metamorphosed breathing, also indicates a cavity.

One of the most important signs of lung tuberculosis is râles, which, not only by themselves in early cases, may make the diagnosis certain, but in the majority of cases give the most trustworthy indication of the extension of the disease. It must be emphasized, of course, that the affection of the lung may last a long time free from calarrh, solely in the form of chronic infiltration, which alone can be shown by alteration of the breath sounds and the results of percussion. Râles depend on the presence of secretion in the air tubes. They are the more numerous the thinner and more abundant the secretion; their size and loudness depend on the size of the space in which they are produced.

According to number the râles may be designated occasional, scanty, fairly numerous or numerous; according to size as crepitations, fine, medium, or coarse râles; according to character as consonant, tinkling, or metallic. A division between dry and moist râles is not to be recommended, but it is better to reckon as rhonchi, and not as true râles, those assuming a thick or dry character, and to speak of crackling, rattling, creaking, whistling, humming, or sonorous rhonchi. Bullersack considers the dry crackling râles and rhonchi to be due to unequal elasticity and abnormal tension in consequence of morbid changes in the parenchyma of the lung.

All the morbid sounds that have been mentioned appear in the various stages of tuberculosis, often combined in many different ways. Those sounds which are distinguished by their position, localization and duration, are particularly valuable for the diagnosis of tuberculosis, especially if other manifest clinical symptoms are absent. Of the greatest value for diagnosis and prognosis is the fact that these catarrhal sounds, even in progressive disease, are often first made perceptible by cough, while they cannot be heard in the least even on deep breathing. Therefore each portion of the lung must be examined during quiet respiration, and also during deeper breathing after a cough. Whoever omits that shows a want of care. We meet many cases in which even numerous râles can only be detected after the patient has coughed some four or six times, one after another, without inspiring between, like the cough of whooping cough, and then takes a deep breath. We like to employ this manoeuvre in every case in which catarrh is absent, but only after percussion has been performed and the character of the respiratory sounds noticed.

Noises which may be confused with râles can be produced by hairs, by very dry skin, or by insecure placing of the stethoscope. Also the muscles and tendons of the head and shoulder-girdle give rise to sounds if the patient is in an unsuitable position. The shoulder noises, which are produced by friction between the shoulder-blade and thorax, and may be of a crackling, creaking, or rubbing character, are, according to Turban, removed usually by repeated rotation of the outstretched arm. Other extraneous sounds are produced by swallowing movements of the patient, for which one must be on the lookout. Ascending sounds from the œsophagus, and similar noises caused by movements of the stomach and intestines, are more easily discriminated.

A sharp distinction between pleuritic and pulmonary sounds

Index of Signs.

ALTERATIONS OF PRECISION SIGNS.

Great attention or distress	□	Gibber's sign	—	G
Slight attention or abatement of same	□	Warrick's sign	—	H
Altered position of margin of lung	—	Frederick's sign	—	F
Great displacement of margin of lung	—	Burner's sign	—	B
Traversable note	—	Cackled note	—	C

CHARACTERS OF THE LABORATORY SIGNS (DATA FROM LEFT TO RIGHT).

Brath sound weakened	—	—	—	—
Brath sound increased	—	—	—	—
Brathless breath sound	—	—	—	—
Intermediate sounds (brathless-brathful or brathful-brathless)	—	—	—	—

CHARACTERS OF THE THERAPEUTIC SIGNS (DATA FROM LEFT TO RIGHT).

Brath sound weakened	—	—	—	—
Brath sound increased	—	—	—	—
Brathless breath sound	—	—	—	—
Intermediate sounds	—	—	—	—

Coughed breathing

Local weak breathing

Apnoeic breathing

Crepitations

Fine or small bubbling rales

Medium bubbling rales

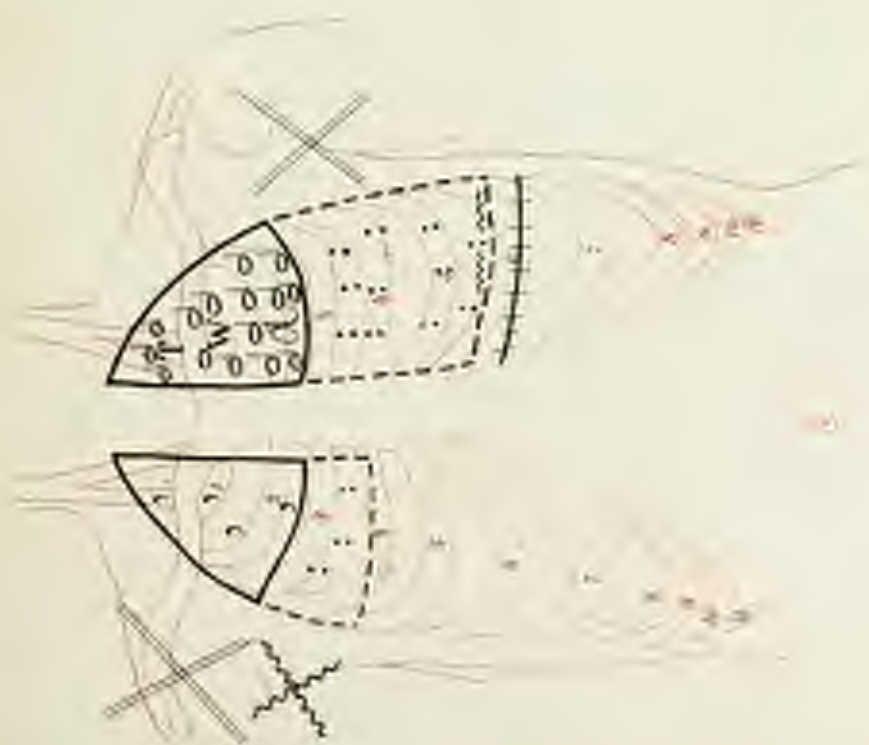
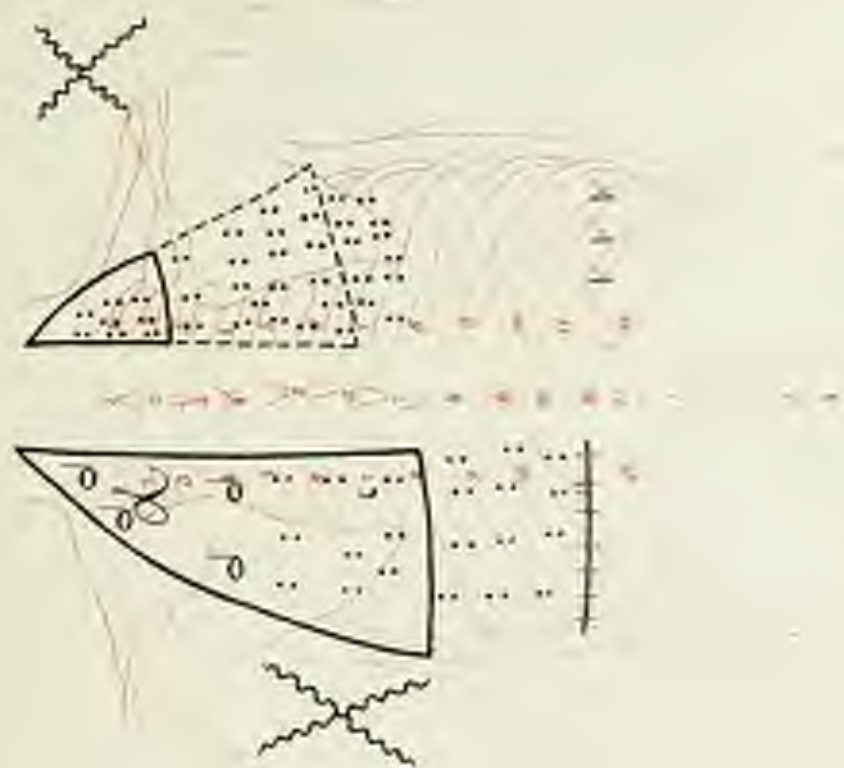
Large bubbling rales

Dry crackling rales

ABNORMAL SIGNS.

Fine crackling rales	—	—	—	—
Medium crackling rales	—	—	—	—
Large crackling rales	—	—	—	—
Musical sounds (humorous and upward)	—	—	—	—
Prose sounds	—	—	—	—

Special precautions, for which no small signs are provided, may be written in abbreviations on the margins.



is often very difficult or quite impossible. The following are some points of difference: The pleural rub is audible during the whole of inspiration and also during expiration, it is most easily heard at the height of inspiration, it is not altered by cough, it is increased by pressure with the stethoscope, it sounds nearer to the ear than the finer râles; but all these aids frequently fail, so that a more prolonged observation is required for a correct decision.

For quickly recording the results of percussion and auscultation, so that at any time they can be recognized in a moment, physicians have for many years employed schematic outlines of the chest, on which each separate departure from the normal may be noted by means of special graphic signs. In the method of employing these signs there is, as yet, no agreement; the attempt to come to an international arrangement on the graphic recording of lung sounds will certainly not succeed. Nevertheless, the proposals of Nahm and Pischinger contain the essential parts of many different ideas. We therefore give here the graphic signs, and, as an example, also a schematic representation of the results of percussion and auscultation.

Auscultation will be completed by the examination of the whispering voice, the changes of which are chiefly associated with bronchial breathing. Particularly it may give information of small infiltrations quite in good time, when there is still doubt about the presence of bronchial breathing, and especially if the patient is breathing badly on account of pain (Sahli). Pectoriloquy and egophony are sometimes heard also over infiltrations. Both phenomena are really forms of exaggerated bronchophony.

Easily, mention must be made of the apparently little-noticed subclavian murmur, a systolic blowing sound over the subclavian artery, more often heard above than below the clavicle; it may be present during both phases of respiration or partly in inspiration, partly in expiration. When it is only just audible it may be increased by forcible inspiration, more rarely by deep expiration; sometimes by this means it is first brought into observation at the height of one or other movement. These facts prove that it is a stenosis murmur. It is produced by an adhesion of both pleural surfaces to each other and to the wall of the subclavian artery. Whether it may also rarely occur in health, as has been asserted, is difficult to say; in any case, it is most frequently found with apical tuberculosis. As the result of our prolonged observations we consider ourselves justified in holding unilateral subclavian murmurs as indicative of tuberculosis.

If the results of percussion and auscultation are opposed to each other it may be asked which of the two fundamental methods is of more value for the diagnosis of early disease. We hold such a question to be idle for the following reasons. Percussion informs us of the density of the tissues, and with the necessary practice allows quite the smallest departure from normal to be recognised. It can also detect a nodule of disease at a time when auscultation still gives no information. Therefore v. Römberg gives as much weight to the percussion results in detecting a focal reaction after a diagnostic tuberculin injection, when auscultatory signs are absent. The difficulty only is that percussion in many cases, so put it shortly, reveals too much; for example, healed mischief or non-specific processes. Also spinal curvature, asymmetrical development of the thorax, abnormal position of the clavicle and the neighbouring ribs, pathological thickening of the overlying tissue, swollen lymphatic glands in the supra-clavicular fossa, &c., may affect the percussion results in a misleading way, and auscultation clears up the question.

On the other hand, alterations of the breath sounds and fine catathedral signs may with certainty indicate tuberculosis, while percussion leaves one quite in the lurch as only gives uncertain results. The conclusion, therefore, is that each method must be used to complete the other to obtain the best possible result from physical diagnosis.

III. Bacteriological Diagnosis.

The finding of tubercle bacilli in the sputum affords the surest evidence of the existence of pulmonary tuberculosis. On the other hand, patients with undoubted phthisis may, owing to septic complications, expectorate large quantities of sputum, in which, in spite of careful examination, tubercle bacilli cannot be found. This means that the quantity, colour and character of the sputum afford no indication of the presence of tubercle bacilli, even if it comes from a lung which, on clinical grounds, is doubtless tubercular.

Technique of Sputum Examination.

The examination of the sputum may be simply, reliably and cleanly carried out in the following way: The patient must be instructed to expectorate some of the real sputum, without troublesome admixture of mucus from the throat or nose, into a clean glass vessel. A naked-eye examination must precede the microscopic search. By this means it is seen if it has a mucoid, purulent or bloody character; if it is thin, tenacious, gelatinous orropy; the form, size and density of the separate masses are noticed, its smell is observed, and also whether it contains carbon particles, bacterial pigments, or blood-colouring matter, granules or tissue fragments.

The examination should take place as soon as possible, as on standing long the staining properties of many of the tubercle bacilli suffer, and, from the destruction of the leucocytes, the characteristic connection between them and the bacilli is effaced.



Acid-fast bacteria in sputum.
(After Lichenowicz, Ziemer, C. Tab. Bd. III.)



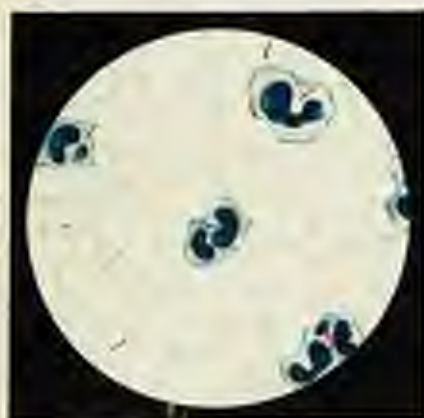
Pseudotubercle bacilli in pharyngeal mucus.
(After Kayserling, Ziemer, C. Tab. Bd. III.)



Tubercle bacilli in sputum.
(After Hirschowitz, Ziemer, Ziemer, Bd. II.)



Lymphocytic sputum with tubercle bacilli.
(After Wolff, Ziemer, Ziemer, and Ziemer, Ziemer, Bd. II.)



Intra-cellular tubercle bacilli in sputum.
(After Tschirg, Ziemer, Ziemer, Bd. X.)



Granular form of tubercle organism.
(After Ziemer, Ziemer, Ziemer, and Ziemer, Ziemer, Bd. X.)

The material to be examined should be taken from the thickest, most cellular part; the small, firm granules, which usually come from a cavity, should be sought for. To aid the search it is useful to spread the sputum on a black dish or on a glass slide on a black background. The chosen particles are picked up with sterilized platinum needles from about ten different parts of the sputum and spread in the thinnest and most uniform layer possible on a slide.

Staining Methods.

As soon as the preparation is quite dry it is passed slowly through the flame three times, with the sputum side upwards, in order to fix it, and is then stained in the following way by Ziehl-Neelson's or Gabbet's methods:—

(1) Ziehl-Neelson.—Stain for two minutes in hot (will bubble form), or better for twenty-four hours in cold, carbol-fuchsin (fuchsin 1, absolute alcohol 10, ligatized carbolic acid 5—dissolve, then dilute with distilled water 100); decolorize for five seconds in 25 per cent. sulphuric acid or 50 per cent. nitric acid; wash in 60 per cent. alcohol until the preparation is colourless (if necessary, repetition of the decolorizing and washing); counter-stain with methylene-blue (1 part saturated alcoholic solution of methylene-blue, 4 parts water); wash in water.

(2) Gabbet.—Stain in carbol-fuchsin as above, decolorize and counter-stain at the same time for one to two minutes in Gabbet's solution (methylene-blue 2, 25 per cent. sulphuric acid 100).

These two processes have kept their place till to-day as the customary and best methods, in spite of many new modifications. If the results of the examination are not satisfactory, it must not be forgotten that staining for twenty-four hours in the cold gives better results than the hot method, a fact which may be of decisive importance in the discovery of scanty bacilli with bad staining properties.

Estimation of the Number of Bacilli.

The number of the bacilli can be recorded most conveniently by Gaffky's scale, which gives the average number found in a field. For practical purposes they may well enough be classified as scanty, fairly numerous and very numerous. If the bacilli are very few an examination of the sputum of two or three successive mornings will generally be successful. If the expectoration is very scanty it may be collected in a well-stoppered glass bottle containing a little carbolic lotion, the patient using this for several days.

Antiformin Method.

In spite of these precautions, the discovery of scanty bacilli in very abundant sputum, such as is produced by a secondary septic infection, may be very difficult. For such cases several methods

have been suggested; the sputum may be made homogeneous, may be rendered less copious, may be divided by sedimentation or centrifugalization. These methods are both complicated and lengthy, so that for practical purposes they hardly come into consideration. All the more important therefore is the antiformin method which Uhlenhuth has lately introduced into practice. It marks a great advance in the practice of sputum examination, and according to the observations of many, including ourselves, gives better and quicker results.

Commercial antiformin, a happy combination of liq. *sod.* hypochlor. and caustic potash, has the property of dissolving all bacilli with the exception of the acid-fast organisms (*timothy-grass*, *butter*, *leprosy* and *smegma* bacilli), which owe their resistance to their fatty envelope. At the same time, owing to the addition of antiformin, even the thickest sputum is dissolved into a state of almost uniform fluidity in several hours (at the longest twenty-four) at the ordinary room temperature, and, as a rule, forms a sediment easily. By the addition of spirit, which lowers the specific gravity of the mixture, or especially by centrifugalizing, the sedimentation will be naturally hastened. The sediment is then washed with distilled water to remove the strong alkalinity and to facilitate its fixation. The adhesion of the sputum to the slide may also be increased by the addition of a little fresh sputum of the same sample, or of a little white of egg or glycerine albumin.

After trial of all the known modifications we have had the best results from the method worked out by Schalte under Uhlenhuth's direction in the Imperial Health Office.

One part of sputum and two parts of 50 per cent. antiformin are mixed in an Erlenmeyer's flask, shaken up and allowed to stand till the sputum is completely broken up (up to thirty minutes). Three parts of rectified spirit are then added, and the mixture is shaken and centrifugated for half to one minute. The lowest part is spread over a slide, the dried preparation fixed above a flame and stained by Ziehl-Neelsen or Gabbet's method. If the bacilli are present in the sputum at all they will be found with tolerable certainty.

Löffler finds a greater number of tubercle bacilli if the mixture of antiformin and sputum is boiled to more complete homogeneity.

Still more exact, but more complicated, is the Ellermann-Erlundsen's modification of the antiformin method by incubation.

One part of sputum is mixed in a graduated centrifuge tube with a half part of 0.5 per cent. sodium carbonate solution, and the mixture allowed to stand for twenty-four hours in an incubator at 37° C. The greater part of the upper fluid portion is drawn off, the bottom centrifugated, and the fluid again drawn off. Then to one part of the sediment

is added four parts of 0.25 per cent. sodium soda, and the mixture boiled with careful stirring. After cooling it is again centrifugured and the sediment used for the microscopical preparation.

Löffler's Chloroform Modification.

Löffler's modification of the antiformin method requires a good centrifuge, and makes possible the discovery of the bacilli in fifteen to twenty minutes. According to Löffler's directions it is as follows:—

A measured quantity of sputum (5, 10 or 20 c.c.) is mixed in a flask of Jena glass with the same quantity of 30 per cent. antiformin and boiled. A frothy and light brown solution is formed at once. To 10 c.c. of the solution is added 1 c.c. of a mixture of ten parts of chloroform and ninety parts of alcohol. After thorough shaking, best in a flask with a piston stopper, the fluid part is centrifugulized for fifteen minutes. There is then a layer of material centrifugulized out, and above it the chloroform. The fluid part is drained off, and the whole of the other material is placed on the slide. After removal of the superfluous liquid with a filter paper, and the addition of a drop of egg-albumen, preserved with 0.5 per cent. tartaric acid, the material is spread with a second slide.

Antiformin- ligroin Modification.

If a good centrifuge is not obtainable the antiformin method can be combined with the ligroin modification of Lange and Nitsche. There is a great affinity between tubercle bacilli and hydro-carbons (ligroin), so that on careful shaking with some drops of hydro-carbon they are more fully separated and carried to the top, and found in great numbers at the junction of liquids. The antiformin-ligroin method, according to Schulte, is as follows:—

Ten c.c. of sputum and 20 c.c. of a 20 per cent. antiformin solution are shaken together from time to time till they form a homogeneous solution. 20 c.c. of water is added and shaken, and then 2 c.c. of ligroin, the mixture being thoroughly shaken till a thick emulsion results. It is placed in a water-bath at 50° C. till there is a clean separation; 1-2 c.c. of methylated spirit carefully added drop by drop, and material removed to a slide with a platinum needle, and treated as before.

The combined antiformin-ligroin method is considerably longer, but it gives, without a centrifuge, reliable results owing to accumulation of the bacilli at the junction of both media.

An evident drawback of the antiformin methods is that all the cellular elements, and also the leucocytes and elastic fibres, are completely dissolved, so that if one wishes to observe these the antiformin method cannot be employed.

Position of the Tubercle Bacilli.

The position of the tubercle bacilli inside the leucocytes of the sputum has a certain value, which has not yet been sufficiently examined. It is generally a favourable prognostic sign, and is

especially observed in cases improving under the influence of tuberculin treatment.

Eosinophile Cells.

According to Teichmüller the sputum contains eosinophile cells for months before the bacilli appear, and with the appearance of the bacilli the cells diminish or disappear. With a favourable course of the disease there is an increase of these cells, with an unfavourable course a diminution, in which Teichmüller sees the working of a defensive mechanism against the infective organisms. From our own observations we cannot endorse these results; we can recognize no clear connection between the eosinophile cells and the prognosis of tuberculosis.

Elastic Fibres.

Elastic fibres in the expectoration indicate with certainty the presence of destructive processes in the trachea, bronchi, or substance of the lungs; mostly they appear in consequence of tubercular necrosis of the parenchyma of the lungs, but are absent in stationary tuberculosis when no tissue destruction is going on. On the other hand elastic fibres may proceed from abscess of the lung or bronchiectasis, while in gangrene of the lung they are produced in quantities, but are seldom recognized in the sputum, as they are quickly destroyed by some substance still unrecognized chemically (ferment?). Elastic fibres are thus in no way pathognomonic of tuberculosis. They are quite bright, of double contour, and often bifurcated, frequently undulating or rolled together, crushed or curled at the ends; they often present an alveolar arrangement.

Elastic fibres have great powers of resistance to alkalis, a fact which is useful for their detection.

A suspicious particle of sputum is treated on a slide with a small drop of 10 per cent. caustic potash. If the fibres are very scanty it is useful to make the sputum homogeneous and allow it to form a sediment; the sputum is well shaken with 10 per cent. caustic potash, perhaps also boiled, till the whole is homogeneous; it is then allowed to form a sediment, or centrifugated, and the sediment examined. Confusion may be caused by particles of food, which might be mixed with the sputum, by cottonwood fibres (without double outline), and by crystals of fatty acids (coloured by heat).

Pseudo Tubercle Bacilli.

A confusion with true tubercle bacilli may be caused by pseudo tubercle bacilli; as the smegma bacilli in secretion from the throat and nose, or from a furred tongue or coated teeth, and from the follicles of the tonsils; as pseudo tubercle bacilli of milk or butter; or from acid-fast bacilli in gangrene of the lung and fibrinous bronchitis, which are occasionally expectorated. The distinction

between true and pseudo bacilli in the sputum has thus a similar importance for the diagnosis of phthisis as the differential diagnosis between smegma and tubercle bacilli has in uro-genital tuberculosis. But if the bacterial diagnosis is not divorced from the clinical examination this distinction will not be of great importance. The differential diagnosis may be made as follows:—

The sputum is shaken up with sterile culture broth and incubated for some time at a temperature of 37°C . If there is a continued distinct development of acid-fast bacilli they are pseudo tubercle bacilli, as true tubercle bacilli do not multiply under these conditions.

This method is simpler and still more trustworthy than animal experiment, since pseudo tubercle bacilli in large numbers are also able to produce a disease with nodules resembling experimental tuberculosis. In contrast to the tubercle bacilli, however, they lose their peculiar staining properties in their fresh development, and so may further be distinguished.

Other Bacteria in the Sputum.

For the recognition of nearly all the other bacilli in the sputum a second preparation stained with weaker carbol fuchsin (1 to 10 aq. dest.) for a short time in the cold is serviceable. We need not consider here the further differentiation of bacteria which may be present in tubercular sputum, such as streptococci, staphylococci and diplococci, *Micrococcus tetragenus*, *Catarrhalis*, and influenza bacilli. For the recognition of the most common streptococcal forms Gram's method, with or without Weigert's modification, is of great service.

Much's Granula.

For the interpretation of the Gram-positive forms great caution is required, since it has been shown by Much that there is a granular form of the tubercular organism, which can only be made visible by a certain modification of Gram's method.

The staining method (Gram II) given by Much is as follows: The thinnest possible film is left for 24 to 48 hours in a solution of methylene violet 110 i.e. saturated alcoholic solution in 100 c.c. two per cent. carbolic acid solution at 37°C , or the slide, covered with the solution, may be heated to boiling. After washing, the slide is placed in sodium potassium iodide (1:2) two to three minutes, in five per cent. sulphuric acid one minute, in 5 per cent. hydrochloric acid ten seconds, and finally, one minute in acetone alcohol (equal parts), and is then washed and dried.

This method of staining brings out the bacilli in different forms, partly developing, partly degenerating; having lost their free fatty acid the bacilli no longer stain with Ziehl-Neelsen, but only with Gram.

Observations, which we also can confirm, show that in sputum preparations from tubercular patients, beside the Ziehl-Neelsen staining bacilli there are as a rule to be found Much's

granules in rod form, staining by Gram II method. The rarer isolated granules are to be received with greater reserve. They may be recognized by their rod form from the other cocci, nucleoli, and dirt particles. A certain alternation between the two forms of tubercle bacilli has been observed, in so far as, with the diminution of the acid-fast bacilli, the number of granules increase proportionally, a change which we have not been able to observe. On the other hand, our systematic observations have shown that in the sputum of clinically manifest tuberculosis in which even with the antiformin method Ziehl-Neelsen staining bacilli cannot be found, Much's granules isolated, or in rod form, may be observed in fewer or greater numbers. The practical interest lies in the great importance of employing the above-mentioned staining method for granules if the examination of the sputum is negative. Whether Much's granules are to be considered as a breaking-down form of the tubercle bacillus, or as its true resting form, or as a relatively weakened variety of the organism, we cannot yet decide.

In all probability they are not any special form of tubercle bacilli, but the chemically-resistant constituents of the normal bacillary bodies, whose nature is not sufficiently known. Liebermeister considers them identical with the Baker-Ermit corpuscles, which are seen in different bacteria; according to him they have nothing to do with Spengler's bodies and are not spores, since spore-forming bacteria are found with them.

Albumin Reaction of the Sputum.

French authors, especially Roger and Léry-Valensî, have stated, not as a new fact, that tubercular sputum contains albumen constantly, and that its presence has value for diagnosis even in early cases, still doubtful clinically. The albumin reaction is likewise positive according to many observations, but not with the same regularity, in non-tubercular inflammatory affections of the lung, as pneumonia, pleurisy, bronchiectasis, gangrene, infarct and œdema of the lung; more seldom in the different forms of passive congestion; never, however, in simple and chronic bronchitis, or in emphysema. The value of the reaction lies in this: that a negative result in doubtful cases, with great probability, is against the existence of an active tuberculosis, while a positive result is only of importance if the above-mentioned non-tubercular diseases can be excluded.

Bernacki, whose observations are in accord with what has been stated, has also systematically estimated the amount of albumin present quantitatively, and has found in active tuberculosis about two per thousand. Schaefer also recognizes the value of the reaction, and thinks it valuable, especially for early diagnosis. In connection with the enthusiastic albuminuria of phthisis described by Lillke and Ström, we may conclude that the albumin is derived from the bronchial and alveolar vessels in consequence of a toxic irritation from an active tubercular focus.

We have examined the reaction in a large series of tubercular cases, equally of the open variety, and have throughout found it positive; in several cases of acute or protracted bronchitis the result was negative, or there was only a very slight turbidity. We agree with Prosek that the amount of albumin in the tubercular sputum has no connection with the stage of disease or the amount of pus in the sputum. The value of the reaction for early diagnosis appears to us not sufficiently proved; and we do not regard it highly for this purpose, as really early cases provide no sputum.

The albumin reaction is obtained in this way. Fresh sputum, as free as possible from saliva, is thoroughly mixed with an equal quantity of water, and several drops of acetic acid added, the mucous thus precipitated being filtered off; this process is repeated till no more mucus comes down. The clear filtrate is then examined for albumin by one of the methods employed in urine analysis, and for quantitative purposes Esbach's rule may be employed.

Stimulating the Expectoration.

It not infrequently happens, especially in women, that it is necessary to stimulate the production of sputum, so that it may be examined and tubercle bacilli sought for. The simplest method is the application of a cotton-wool jacket at night, followed by a cold friction in the morning on removal of the packing; the stimulus may procure the expectoration of the scanty secretion produced under the influence of the warmth. In a similar way inhalation with saline solutions, the internal use of alkaline mineral water, or of potassium iodide may have some effect. The diagnostic tuberculin injection may sometimes produce, during the reaction, sputum containing bacilli.

In those cases in which there is a suspicion that the sputum is swallowed, or when the patient has been observed to swallow it unconsciously, and this again occurs more often in women than men, the bacilli may be sought for in the expelled stomach contents or in the feces; the latter examination being much facilitated by Uhlenhuth's method.

Prognostic Value of Tubercle Bacilli.

With regard to the prognostic value of bacilli in the sputum it may be said in general that with advancing disease not only is the percentage of bacilli, but also their total number, large. This point has no value in practice, since sometimes in initial tuberculosis the bacilli are found in large numbers, while in rare cases of advanced phthisis they may be altogether absent.

Diagnostic Value of Tubercle Bacilli.

It is agreed that the discovery of tubercle bacilli in the sputum is the surest sign of the existence of pulmonary tuberculosis; but it gives no indication of the form, the progress, and the prospects of healing of the disease. For the early diagnosis of phthisis the bacteriological examination is of

very small value, as only about a tenth of all really first-stage cases produce sputum containing bacilli. It is therefore a sad confession of want of skill to allow the diagnosis of tuberculosis to depend upon the bacteriological examination, or to wait for the appearance of bacilli in the expectoration; the most favourable time for treatment will be lost, for the successful management of phthisis stands or falls with early diagnosis.

Animal Inoculations.

Animal experiment is the sovereign method of proving the existence of tuberculosis, when the discovery of bacilli in stained preparations from the sputum, exudate, blood, or urine fails. The most suitable method is the intraperitoneal inoculation of susceptible animals, especially guinea-pigs.*

Kiralyi found in eight to fourteen days after the infection the retro-jugular glands to be enlarged, caseating, and containing bacilli, at a time when tubercular changes could not be recognized in the other glands or in the organs.

Bloch's Gland Crushing Method.

The usual intraperitoneal or subcutaneous inoculation has the drawback that it entails a delay of four to six weeks, and even after this time the changes may be so slight that they can only be shown with certainty by a microscopical examination. A shortening of this period may be obtained by Bloch's method of crushing the glands of the groin after inoculation in the inguinal region.

Bloch has lately improved the method by treating the material to be examined with weak antiformin, the other bacilli are thus destroyed and the probability of sepsis diminished. After nine to eleven days the crushed glands are extirpated, treated by the antiformin method, and examined for bacilli.

Intra-Hepatic Inoculation.

Oppenheimer practises the inoculation into the liver, with the idea that this organ offers a good developing ground for the bacilli, and is a place where the tubercular nodules can be recognized at an early stage of development. Up till now he has only employed this method for examination of the urine; every case of tubercular urine was positive, every control experiment with non-tubercular material negative. Further controls have shown that pseudo-tuberculosis or coccidiosis gives rise to no changes which can be confused with tuberculosis.

According to our observations the intraperitoneal injection gives by far the most certain results, though it takes rather

* The technique of the animal experiments has been omitted, since in England they can only be performed in licensed laboratories.

longer. At all events the older method should always be combined with Bloch's or Oppenheimer's methods as a control.

Lately Jacoby and Meyer have attempted to hasten the proof of tuberculosis in animal experiments by means of the increased sensitiveness to tuberculin. They obtained in 80 per cent. of the cases a positive result by the following method: "If one introduces a sufficient number of tubercle bacilli, for example in infected sputum, into the peritoneal cavity of a guinea-pig, and after about fourteen days gives the animal a subcutaneous injection of 0.3 c.c. of tuberculin, it will die in several hours with an extremely low body temperature."

The authors employ these methods as a control combined with Bloch's gland crushing, and pay special attention to Kirsch's sign of enlarged retro-pagular glands.

IV. Diagnosis by Means of Tuberculin.

Tuberculin is the most exact and finest reagent for proving the existence of a tubercular deposit in the living organism. There are three methods chiefly to be considered, the cutaneous, the conjunctival, and the subcutaneous-tuberculin tests; all three can be carried out with Koch's old tuberculin.

Cutaneous

Tuberculin Test.

The cutaneous tuberculin test of v. Pirquet depends on the super-sensitiveness of the skin of a tubercular person to a small amount of inoculated tuberculin. The tuberculin and the antibodies, which are the products of reaction against the existing infection of the body, combine together and produce a reaction at the point of inoculation after twenty-four to forty-eight hours in the form of an inoculation papule of a specific tubercular nature. If the organism is still free from tubercular infection there are no antibodies, and therefore the conditions of reaction fail, and no papule forms.

The cutaneous test is done by placing drops of 25 per cent., or in adults of pure, tuberculin some four inches apart on the inner side of the forearm on two spots previously cleaned with ether. The skin underlying the drops, and also previously at a spot between as a control, is perforated with a v. Pirquet's borer, which makes a uniform, round, superficial hole in the skin. After inoculation the tuberculin is left for several minutes on the superficial abrasion; a bandage is not necessary afterwards.

A negative result of the cutaneous test is in general indicative of freedom from tuberculosis; if the skin does not react the

person may be considered free from tubercle in the anatomical sense with the greatest probability. A positive skin reaction shows that the body has at some time and in some way been infected with tubercle bacilli; thus a reaction may be obtained both with manifest tubercular patients and also with people who clinically are not tubercular, that is with those who are apparently sound, but have somewhere in the body a healed and therefore quite unimportant tubercular nodule. This excessive delicacy of the cutaneous reaction is its great drawback, which almost entirely negatives its importance in adults, since of them 90 per cent. or more carry such obscure tubercular deposits, which have no importance for the physician. The cutaneous reaction, however, is of great value in children, and the more so the younger the child is.

Therefore in adults only the negative result has a diagnostic value, as it excludes the existence of tuberculosis. The cutaneous test is absolutely harmless and has no contra-indication. It has no prognostic value.*

Percutaneous Tuberculin Test.

Of the various modifications of the cutaneous test mention need only be made of Moro's percutaneous test, which is done by rubbing in a piece of 50 per cent. tuberculin ointment of the size of a pea with moderate pressure for one minute into an area of skin of about 10 square inches. In a positive reaction red points, or (confluent) red spots, or even small papules appear in twenty-four to forty-eight hours. The percutaneous method is considerably inferior to the cutaneous in certainty.

Conjunctival Tuberculin Test.

The conjunctival tuberculin test, also known as the ophthalmic reaction (Calmette) and the conjunctival reaction (Wolff-Eisner), is similarly a local tissue reaction, due to the fact that the conjunctival tissues of tubercular persons are specially sensitive to tuberculin. Just as the cutaneous reaction shows the supersensitiveness of the skin, so this shows the conjunctiva possesses the same property, which it shares with all the other mucous membranes of the body; it cannot therefore be considered as an actual discovery.

It is performed by placing in the conjunctival sac of one eye a drop of freshly prepared 1 per cent. tuberculin solution, and if the result is negative two days later a drop of 4 per cent.

* Attempts have been made to overcome the excessive delicacy of the cutaneous reaction by using diluted tuberculin. Ellermann and Kridanides have devised a method in which a series of four dilutions are used, the resulting papules being accurately measured; it has been fully described by Morland (*Lancet*, 4545, p. 480).

solution in the other eye, the conjunctiva being brought well in contact with the fluid. It is recommended to do the test in the afternoon and the control on the next morning, and if there is a negative result that it should be again inspected after a further twenty-four hours.

The positive reaction consists of a more or less well marked redness of the caruncle and of the semilunar fold, which may spread to the palpebral and scleral conjunctiva, and in a severe reaction cause chemosis of the whole sac with fibrinous and purulent secretion. Injurious results to the body generally are not met with. Subjective local signs, such as photophobia, irritation, lachrymation, and a feeling as of a foreign body as a rule only occur with strong reactions. On the other hand there are numerous definite published observations of serious and lasting local disturbance of the eye, even of permanent injury to the organ, almost entirely destroying the sight, which cannot be explained by a defective technique or the use of an unsuitable preparation, but must be laid to the charge of the conjunctival reaction itself solely. In consequence of these facts the use of a conjunctival test cannot be recommended as a routine to the careful practitioner, all the more as he has constantly hanging over his head a sword of Damocles in the form of legal damages.

Absolute contra-indications are all diseases of the eye of any nature or any age, even quite quiescent affections; also old age, scrofula, and infancy.

Not only is the conjunctival reaction distinctly dangerous, but it is also markedly uncertain and unreliable. The positive reaction generally only indicates that there is a tubercular focus in the body, it is silent as to its site, its activity, or its inactivity; and a negative result does not prove the absence of tuberculosis. So that a positive reaction is given by cases not tubercular clinically, such as inactive healed cases; and further, a positive reaction has been observed in cases proved free from tuberculosis by post-mortem examination, especially in patients suffering from articular rheumatism, enteric fever, pneumonia, and cancer.

For prognosis the conjunctival reaction is of practically no value, as Calmette himself admits; it is only regarded favourably in respect to the prognosis of phthisis by Wolff-Eisner, in spite of many adverse proofs furnished by ourselves and others. For this purpose the conjunctival reaction is of no more service than the cutaneous. Besides, a method which is not trustworthy for diagnosis can be of no value for prognosis, since prognosis is only a more widely extended, finer form of diagnosis.

In the fiasco of the tuberculin eye-drops is also involved the

similar modification recommended later by Wolff-Eisner of testing the conjunctiva by means of tuberculin-caselin, which is attended by still greater drawbacks and dangers.

Subcutaneous Tuberculin Test. The subcutaneous tuberculin test is the most practically serviceable, and most fertile in results, of the diagnostic methods.

The doses for adults are:—

Initial dose	0.2 c.mm.
First increased dose	1 "
Second increased dose	5 "
Last dose	10 "

For children half the *c* doses is sufficient. The dilution of the tuberculin is performed under antiseptic precautions with 0.5 per cent. carbolic acid. Between the separate injections at least forty-eight hours must elapse. It must be most forcibly emphasized that the next dose is only to be increased if the previous dose has produced no rise of temperature. If the temperature is only slightly raised the next dose must not be increased, but the same quantity be given again, and not till the temperature has completely returned to normal. The increased reaction which then usually occurs is an infallible sign of the existence of tuberculosis. If these precautions are carefully observed bad results from the tuberculin will not be met with.

There are altogether four divisions of the tuberculin reaction: the reaction at the site of injection, the febrile reaction, the general reaction, and the reaction at the seat of disease. These reactions may all occur together, or one or more may only be observed. The febrile and general reactions are most often met with. The reaction may be regarded as positive if the injection raises the temperature at least 1° F. The most trustworthy is the local reaction, which can generally be detected if the patient is examined at the commencement of the reaction. If it can be detected objectively, or only subjectively, an active tuberculosis may be diagnosed with certainty.

Confusion may be caused by a pseudo-reaction, such as may occasionally be caused by an intercurrent febrile disease, which cannot be immediately recognized, as tonsillitis, alveolar abscess, &c. Rises of temperature from psychological causes or suggestion must be remembered. They are met with in persons of unstable nervous systems, hysterical, neurasthenic individuals, and may be induced by an injection of distilled water, which can with advantage be used as a control injection.

**Contra-
indications.**

Contraindications to the employment of subcutaneous, diagnostic tuberculin injections are: (1) A temperature above 99.2° F. in the mouth or 99.8° F. in the rectum; axillary temperatures are not reliable; (2) recent hæmorrhage from the mouth of uncertain origin and cause; (3) heart disease; (4) kidney disease; (5) epilepsy, and severe cases of hysteria and neurasthenia; (6) a suspicion of miliary or bowel tuberculosis; (7) severe diabetes, apoplectic tendency, advanced arterio-sclerosis, amyloid changes in the abdominal viscera; (8) convalescents and persons weakened by severe disease.

Indications.

The indications for the subcutaneous tests are: (1) In clinically doubtful cases for making certain the early diagnosis; (2) in cases of difficulty in the differential diagnosis, for deciding the line of treatment.

A negative result excludes with certainty an active tuberculosis. A positive result indicates with certainty the presence of a tubercular focus, and even assists to a certain degree in differentiating between active and inactive disease, and between recent or old deposits. Fresh and active disease usually reacts promptly to the smaller doses, while old changes of a more chronic nature only as a rule to the higher doses, and, indeed, frequently show a delayed reaction. A further indication is that a large proportion of cases show a reaction at the seat of disease, demonstrating the active character of the process. These focal reactions may be either discovered objectively, as by the augmentation of the physical signs, or may show themselves subjectively by oppression of the chest, pain, dyspnoea, irritative cough, &c. Also the early diagnosis may be made from pleural irritation as a result of a tuberculin reaction.

The subcutaneous tuberculin test is, in conjunction with the other results of clinical examination, history of the patient, temperature, &c., the sovereign method of diagnosis for the recognition of active, early, lung tuberculosis in adults. It gives the most important information in all doubtful cases, but must be practised with due care to avoid harmful effects. We have given an outline here which may be filled in by reference to our book on "*Tuberculin in Diagnosis and Treatment*."

V. Diagnosis by Röntgen Rays.

The examination by Röntgen rays has of recent years become of special interest, since it has been employed more than hitherto for the diagnosis of tuberculosis of lungs, thanks to refinements

of technique. The diagnostic results are essentially improved, but still to-day opinions as to their value differ, according to the standpoint of the writer and his line of work. Whilst for example Rieder ascribes to the Röntgen-ray examination a most important value, not only for the recognition of chronic lung tuberculosis itself, but also of its secondary changes and complications, A. Frankel denies its wider value, and considers that only in solitary nodules, especially in tubercular peribronchitis, have the rays been of service in improving the diagnosis.

We agree rather with Rieder, and will point out in the following short sketch what information the Röntgen rays may give. But we must first say that according to our results the rays for early diagnosis are of very small importance. One must clearly understand that the rays can only give a shadow picture of the lungs which is affected by the thickness of the media, so that the really initial changes must be missed, that further they can give no information as to the specific nature or activity of the disease, and that lastly there is a great difficulty in correct observation and correct interpretation of the shadows.

Changes in the Lungs.

According to Ziegler and Krause an isolated tubercular nodule must have an area of about 4 square millimetres, and lie near the plate, before it can give a shadow. Catarrhal changes without condensation are also not visible. It is also most difficult to decide whether small isolated shadows are tubercular nodules and glands, since the crossing of bronchi and vessels will normally give shadows. The intensity of the shadow given by small tubercular nodules is practically the same whether they are formed of caseous tissue, of closely packed miliary tubercles, or of connective tissue. Larger nodules of caseating material, of dense connective tissue, or of calcification give dark shadows, more or less differentiated and circumscribed. Cavities, of even quite small diameter, can be easily recognized, if they are well encapsuled, being then characterized by a darker ring of shadow round the periphery. But even larger cavities are not visible if they are surrounded by dense infiltration, or if they are obscured by the shadow of thickened pleura. The contents of the cavity seem to influence the clearness of the picture little or not at all. Miliary tuberculosis of the lung can also be recognized by the marbled appearance. Slight pleural changes are not distinguishable; dense adhesions, thickenings, and exudation give intense shadows. Apical disease first gives a shadow when the air contained by the tissue is considerably diminished; isolated nodules must also reach a certain size before they can throw a definite shadow, if

diffuse infiltration has caused a uniform darkening of the apical regions.

Healed or non-tubercular processes may cause difficulty in the differential diagnosis by causing apical shadows; for example, cicatrices at the apex, pleural thickening, enlarged glands in supra-clavicular fossa, low position of the thyroid glands, fatty deposits, scleroderma, or other thickening of the skin, the subcutaneous tissue or the muscles, abnormal position of the clavicle and first rib or slight scoliosis of the vertebral column. According to P. Krause there may be slight shadows from deficient entry of air into the apices in persons who for some time have not breathed sufficiently deeply; sometimes they will clear up during the examination if deep inspirations are taken. From his experience at the Röntgen Institute of the Vienna Poliklinik, Kreuzfeldt recommends the illumination of the lung apices with the softest possible tube, and the weakest possible light; also to move the screen away from the patient to enlarge the shadows of small nodules. He also employs a moderate cough after deep inspiration as an aid to differential diagnosis; in persons with healthy lungs, especially those showing slight accidental shadows due to apical atelectasis, there is constantly seen a brightening of the apices, such as does not, or only very imperfectly, occur in organic disease.

As to the meaning of the much discussed shadow tracks passing from the hilus to the apex there is still no agreement: as they may be also seen in normal cases, their interpretation when associated with pathological changes is very difficult. At all events there is a connection between disease at the apex and the hilus.

Disease of the Root of the Lung.

The Röntgen rays have a special value for the diagnosis of diseases of the hilus of the lung, which are more or less undetected by the other methods of clinical diagnosis.

By the discovery of tubercular nodules at the root of the lung, and of the extensions from them, an early diagnosis becomes possible (Rieder). The difficulty lies in rightly appreciating the differences between the normal shadows of the root of the lung and those only slightly altered; chronic enlargement of the glands at the hilus is no rare occurrence, and may easily simulate tuberculosis of the bronchial glands. The dispute, whether the normal hilus shadow is due to the bronchia or to the vessels, we think with v. Hansemann to be useless, for doubtless both structures in their various planes or crossings throw shadows; as do also the glands lying between them, which in adults usually contain

carbon particles. The experiments of M. Cohn and Weier show that the vessels play the preponderant part.

Further Information Afforded by the Rays. The Röntgen photograph can also give valuable further information on the behaviour of the heart during the course of phthisis; the position of the neighbouring organs, the large vessels, the trachea, and the œsophagus; on the condition of the pleura as to dry and serous pleurisy, or as to the existence of an interlobar, encysted exudation, and as to the after-effects of pleurisy; on pneumothorax and the state of the underlying lung; and lastly, as to the action of the diaphragm. Of distinct value as an early symptom is diminution of the diaphragmatic movement of the affected side, first described by Williams, which consists of deficient inspiratory lowering of the diaphragm from its normal expiratory position.

The most common cause is adhesion of the pleura in different parts. From adhesions of the diaphragmatic pleura various displacements of the diaphragm may ensue (blunt projections, bands of adhesions, undulating contour, flattening, darkening, and diminution of the complementary pleural space, &c.). Of late the well known abnormality of the upper aperture of the thorax and ossification of the first rib cartilage is being observed and studied during life by help of the Röntgen rays.

Differential Diagnosis.

The rays may furnish help for the differential diagnosis, for example, by distinguishing chronic bronchitis, bronchiectasis, and pneumoconiosis, in which affections the alterations of the bronchial tubes can be more or less easily observed by the shadow picture. In the different forms of affections of the lungs by dust particles the appearance is often very characteristic and valuable for diagnosis. The rays also give valuable and indispensable service in the recognition of aneurisms and tumours of the lung and mediastinum, as will be mentioned later.

It is obvious from the foregoing remarks that the Röntgen rays can in many cases give much information as to the nature and extent of the pathological changes in the lung, and that in fact they increase our power of diagnosis. It is further clear that these results must not be taken by themselves, but only in combination with all the other methods of examination at our command must they be carefully and critically employed. He will receive the most assistance from the Röntgen rays who makes the best use of the general clinical and physical examination (M. Cohn).

VI. Other Diagnostic Methods.

For the sake of completeness short sketches are given of several other diagnostic methods, most of which have only recently come into use.

Tubercle Bacilli in the Blood.

The discovery of bacilli in the circulating blood has a certain diagnostic importance. It succeeds the more readily the severer is the form of tuberculosis; but even in clinically slight cases the bacilli are no rarity in the blood. A positive result may under some circumstances settle all diagnostic doubt, especially in clinically uncertain febrile diseases, in which a test injection of tuberculin is inadmissible.

Agglutination Test.

Arloing and Courmont endeavoured to employ for tuberculosis the agglutination phenomenon due to the serum reaction, which has proved of such high value in enteric fever. They succeeded in obtaining by means of a special process of culture a homogeneous growth of tubercle bacilli, and recommended the agglutination test for early diagnosis as the result of 1,200 examinations. The process of agglutination examination was made more useful and reliable by R. Koch's introduction of an agglutinative test fluid; since then much work has been done on this subject in Germany. The results of these researches, including our own, may be shortly summed up in this way: The agglutination test is a most important guide for the specific treatment of tuberculosis, indicating the formation of a specific reactive product associated with immunity; for diagnosis, especially for early diagnosis, it is useless, since the serum from active tubercular cases sometimes gives no agglutination, while on the other hand a positive reaction is often obtained with those who have long recovered from the infection.

Opsonic Index.

Wright has worked out a method, which by a numerical comparison of the results of mixing under stated conditions a fluid containing leucocytes with an emulsion of bacilli, allows the estimation of the opsonic power of a given serum. The proportion between the opsonic capacity of the patient and that of a healthy individual gives the opsonic index, which furnishes an objective measure of the amount of anti-bacterial substance in the blood. If the opsonic index lies above or below certain limits it is a sign that the body is contending with the tubercle bacillus, and is of diagnostic and prognostic value. According to the results hitherto obtained from many experiments, Wright's opsonic method is useful for

the diagnosis of tuberculosis, but we have other methods of simpler technique, less wasteful of time and more certain in their results; the prognostic importance of the opsonic index is slight.

**Complement
Fixation.**

The method of fixation of the complement, according to Bordet and Gengou, facilitates the recognition of the existence of specific antibodies in the serum, and has been worked out by Wassermann for the diagnosis of syphilis with the most important practical results. Attempts have been made to employ a similar process for the early diagnosis of tuberculosis. The question whether this is possible under certain conditions must be answered in the negative. According to our experiments the serum of clinically non-tubercular persons can give the same complement fixation results as the serum of tubercular people. Often, too, as with the agglutination test, the results of an old contest between the organism and the bacillus may suffice to produce the reaction.

**Cobra-poison
Test.**

Calmette's method of making cobra poison active has the same value. It depends on the fact that cobra poison alone in the greatest dilution has no power to destroy blood-corpuscles, but it will do so if mixed with the inactive serum of a tubercular patient. In confirmation of the work of Calmette, we have the results of v. Szabo and Pelanowicz, which were positive up to complete hæmolysis in 94 per cent. of phthisical patients; but we find that non-tubercular sera also make the cobra poison active in a considerable (48 per cent.) proportion of cases. Liddle has even observed 80 per cent. positive results in healthy persons. According to Nowaczynski, the activating substance for cobra poison is also produced in other diseases, such as all the other infections and nephritis, and indeed with greater frequency than in tuberculosis.

Anaphylaxis.

Bauer's discovery of the passive transference of super-sensitiveness to the tubercular poison depends on the fact that healthy guinea-pigs, who have received an injection of the serum from a tubercular patient, become passively super-sensitive, so that they give a typical febrile reaction to a tuberculin injection. The animal experimented on is thus in the same condition as persons who react to tuberculin. Unfortunately this method partakes of the uncertainty of the other serum tests mentioned before. It fails in undoubtedly tubercular cases. Also, according to our experiments, quite indifferent injections, such as milk or saline solution,

may confer sensitiveness on guinea-pigs, so that they will react to tuberculin injections; therefore the test has no specific significance.

Lymphocytic Sputum.

Wolff-Eisner has lately drawn attention to the great frequency of lymphocytic sputum in tuberculosis. The lymphocytes appear in strikingly large numbers in the sputum, under certain circumstances forming up to 50 per cent. of all the sputum cells, both in early and advanced cases of phthisis, and even in those with mixed infection. According to Wolff-Eisner they are an evidence of the presence, or even of the approaching appearance, of tubercle bacilli. The toxins of tubercle bacilli have an attractive power for the lymphocytes, in contra-distinction to the toxins of other bacilli of chronic catarrhal conditions, which have a chemotactic action on the polymorphous leucocytes. Also in other inflammatory changes, such as effusions, a preponderance of lymphocytes is in favour of the tubercular nature of the disease, as was first shown by Wolff-Eisner, and confirmed especially by Vidal. According to these observers the discovery of lymphocytic sputum is of value in cases in which tubercle bacilli cannot yet be found. We have, up to now, not found it with that regularity which would be necessary for an important early sign; also the majority of initial cases produce no real sputum from the lung. The lymphocytes are well stained with Löffler's methylene-blue; the customary counter-staining with methylene-blue in the ordinary process of staining for tubercle bacilli is therefore sufficient for their demonstration. In looking through the preparation one must guard against confusing the lymphocytes with degenerated epithelium and swollen leucocytes.

Increase of Neutrophile Cells in Blood.

The value of Arneth's observations on the increase of neutrophile blood-cells and its connection with tuberculosis will be discussed in connection with tuberculosis of the blood and lymphatic vessels.

VII. Differential Diagnosis.

There are a number of chronic diseases of the lungs and bronchial system, and also of the other intra-thoracic organs, which by their symptoms may simulate tuberculosis of the lungs, and which cannot be always clearly discriminated by physical examination. The chief diseases of this nature will be now briefly mentioned.

**Chronic
Bronchitis.**

Chronic bronchitis affects especially the lower posterior part of the lungs, and from its signs and its course cannot well be mistaken for tuberculosis. It may, however, cause difficulty in the differential diagnosis, in so far as it is a very frequent concomitant of tuberculosis, especially when mixed infection is present. If such a complication should occur the tubercular foci can generally be distinguished from the diffused bronchitis by the limitation of their catarrhal signs to their special regions; where they can be distinguished by their persistence and intensity.

**Asthma and
Emphysema.**

Asthma and emphysema give such a characteristic symptom complex that they likewise do not cause confusion with tuberculosis; at the same time they make its onset more unlikely in consequence of the venous congestion of the pulmonary circulation. In those rare cases in which tuberculosis supervenes on both these diseases, its detection is very difficult in the early stages before the appearance of bacilli. Scattered râles at the apex without percussion changes may be caused by asthma or emphysema; but they may also be the result of tubercular mischief, the signs of infiltration being masked by the emphysematous condition. Frequent examinations, other careful observations, and the assistance of tuberculin will make the diagnosis certain quite early.

Emphysema of the aged requires special attention; behind it tubercular lung changes frequently occur, usually in the form of very slow and albeile, chronic, indurative processes and masked fibroid phthisis. The surrounding vicarious emphysema, producing definite emphysematous pads above the apices, may interfere with the percussion of even marked tissue thickening; but auscultation gives the right diagnosis earlier. In such cases one should not neglect the antiiformin examination of the sputum, which is hardly ever absent. Hoppe-Seyler rightly draws attention to the great danger of infection of the surroundings by these old people with their supposed asthma, often lasting several years.

**Non-tubercular
Apical Changes.**

Of the very greatest practical importance is differentiation of non-tubercular apical changes, which are occasionally produced by pneumonia or influenzal pneumonia. Also certain anatomical conditions, such as slight lateral curvature of the cervical or thoracic vertebrae, unilateral muscular atrophy, dropping of the right shoulder girdle, differences in the course and branching of the apical bronchi, &c., may cause changes in percussion

and auscultation, without any affection of the lung tissue itself. Lately Kulis has notified, from the medical clinic at Berlin, the fact that in young people there may be very regular and constant râles over one apex, causing a suspicion of tuberculosis, but due to a local bronchitis, accompanied by tracheitis and pharyngitis, and often also by emphysema. We must think that a localized bronchitis in such a position is usually of a specific nature; in such cases the diagnostic tuberculin injection will give the surest information.

Collapse and Induration.

In this connection there is also Krönig's collapse and induration of the right lung apex in cases of chronic obstruction to the nasal passages, a condition which gives the physical signs of a right-sided tuberculosis, but aetiologicaly has no connection with that disease. Krönig thinks that an important point in the differential diagnosis is that the respiratory excursion of the lower lung limit, in opposition to what occurs in active tubercular processes, remains unaltered. But this diminished respiratory movement of the diaphragm (Williams's sign), which may be of much value in the Röntgen-ray examination, is only evidence of an accompanying pleurisy, and cannot of itself be a constant diagnostic sign in distinguishing between tubercular and non-tubercular apical induration. The collapse induration may also undergo secondary infection, so that it is recommended to have frequent recourse to the subcutaneous tuberculin test.

Pneumoconiosis.

The forms of pneumoconiosis produced by prolonged inhalation of mineral, metallic, animal and vegetable dust may, on the one hand, simulate a tubercular infiltration, and, on the other hand, very frequently undergo secondary tubercular infection and usually progress unfavourably. An early recognition is therefore of the greatest importance, and for this, as long as the bacilli cannot be discovered in the sputum, there is no better means than the diagnosis by tuberculin. The position of the inner margins of the lung along the sternum affords some information; Bäumlér first described their retraction in pneumoconiosis. The value of the Röntgen-rays has already been mentioned in the section on that subject.

Chronic Pneumonia.

There are similar diagnostic difficulties with chronic pneumonia, which may simulate phthisis, especially when due to streptococci or influenza bacilli, but which may be complicated with tuberculosis; so that the discovery of streptococci or influenza bacilli does not exclude phthisis.

Bronchiectasis, abscess and gangrene of the lung may, by their symptoms and physical signs, cause confusion with phthisical cavities; in these cases the constant absence of tubercle bacilli does not exclude tuberculosis.

Bronchiectasia. Non-tubercular bronchiectasis is usually situated in the lower lobes, and especially in their upper parts about the level of the angle of the scapula, and is much rarer in the upper lobe; it is usually only unilateral. Examination into the history will show the commencement with a pneumonia, a severe acute bronchitis or a pleurisy. The cough is characteristic, occurring in paroxysms usually directly after change of position; the expectoration comes up in mouthfuls and has a faint sweetish odour, which becomes foetid on standing; the masses of sputum stick together, unlike the cavity sputum of phthisis, and on standing form three layers. The bronchiectatic patient usually maintains a good state of health for years; he may be cyanotic or pale, but not cachectic; fever is usually absent; club-fingers are more often found than in phthisis.

Abscess of Lung. For the diagnosis of abscess of the lung the inquiry into the history is of special importance; the disease usually commences with an embolic, genuine, catarrhal, or deglutition pneumonia, sometimes with an injury to the lung. The most important sign is the condition of the expectoration, it is moderate in amount, usually consisting of pure pus, contains many elastic fibres in an alveolar arrangement, tissue fragments and sometimes also hæmatoidin crystals in such abundance as to give it a brownish colour.

Gangrene of the Lung. Gangrene is more easily to be distinguished by the highly penetrating odour, which even affects the air round the unfortunate patient. The copious, dirty-grey sputum contains an enormous number of bacteria, and often large portions of lung tissue, while elastic fibres are scanty on account of the rapid gangrenous destruction; at all events they are not in the number that would be expected.

Syphilis of the Lung. There is often great difficulty in diagnosing between tuberculosis and syphilis of the lung. From the results of numerous post-mortem examinations it is very probable that syphilis of the lung, in the form of chronic indurative contraction of the lung in syphilitic patients, has been diagnosed much too frequently; and that usually the process is tubercular. There is no

characteristic clinical picture of lung syphilis, it generally takes the form of chronic interstitial pneumonia. The catarrhal signs often appear later than the percussion changes. Haemoptysis and fever are rare. If other syphilitic conditions are present at the same time as the lung signs, if tubercle bacilli are constantly absent from the sputum, and if the clinical picture differs much from that of pulmonary tuberculosis, then a probable diagnosis of syphilis of the lung may be made. This probability is much increased if the indurative changes are favourably influenced, even to a slight degree, by treatment with iodide of potassium or mercury. It must be always remembered that tuberculosis and syphilis may be combined, so that diagnosis by tuberculin may not give complete information. It has been maintained that tuberculin may give a local and general reaction in cases of lung syphilis; it is more likely that they were cases of such mixed infection. Wassermann's reaction of complement deviation has also now increased our means of diagnosis.

Neoplasms.

Growths in the lung are usually metastases; the most frequent are secondary carcinoma and sarcoma. The primary tumour in other parts of the body gives the diagnosis if it can be recognized; but often the primary tumour is latent, or quite insignificant in size in comparison with the lung metastasis. For the purposes of clinical diagnosis the primary and secondary tumours are considered together.

The primary tumours of the lungs are very rare; of them cancer of the lung has clinically the greatest importance. There is nothing distinctive about either the subjective or the functional alterations. Also the history of the disease may be absolutely similar to that of tuberculosis. Old age is in favour of tumour, especially if the lung condition is not characteristic of tuberculosis. The symptoms sometimes resemble those of chronic pneumonia, especially as long as the tumour remains limited to the lung substance; at other times compression signs are more prominent. The physical signs are not constant and usually not characteristic; they consist of dulness, often very marked diminution of the breath-sounds, strikingly scanty catarrhal signs, and rarely of cavity formation. Freedom of the apices, exclusive localization in the root of the lung and the lower lobe, sharp percussion outlines, and absolute dulness are all against tuberculosis and in favour of tumour. With the involvement of the pleura the resemblance to tuberculosis is much increased; only unusually intense boardlike dulness is the certain sign of a carcinomatous pleurisy. If there is an exudate, it may be more or less of an aid to diagnosis; tumour cells make the diagnosis

certain, or the cytological examination may be in favour of tuberculosis; hæmorrhagic effusions are more common with tumour than with tuberculosis. But cough, expectoration, pains in the chest, breathlessness, fever, pleural exudation or adhesions, and even hæmoptysis may heighten the resemblance to tuberculosis. Such a case, presenting all these symptoms, we ourselves have lately observed. Repeated hæmorrhages, not influenced by any treatment, combined with paroxysmal attacks of coughing, chiefly raised the suspicion of primary carcinoma of the lung; the observation with Röntgen rays of rapid increase of the disease made the diagnosis certain, and it was afterwards confirmed on post-mortem examination.

Sometimes, however, one of these symptoms may be sufficiently characteristic to furnish the probable diagnosis of a tumour. The cough often comes on in paroxysmal attacks and is accompanied with great cyanosis of the face; like the cough of enlarged bronchial glands it is due to compression of the vagus. Severe, cutting pains, radiating forwards from the spine, are to be explained in a similar way. Other factors for their production, however, are carcinomatous pleurisy and "the direct involvement, displacement and erosion of nerves, especially in the region of the posterior mediastinum, from masses of tumour and cicatricial contraction" (Grau). J. Schwalbe lays stress on the asthmatic attacks; according to Ebstein the dyspnoea may reach a pitch which is never observed in any other disease likely to cause difficulty in diagnosis. The expectoration may be of very various nature; at the commencement it is clear mucus, it becomes more or less purulent from concomitant bronchitis or from the production of bronchiectasis by pressure of the tumour; as destructive processes ensue, masses of debris and tumour particles, visible to the naked eye, or microscopic tumour elements, may be recognized; frequently the sputum is bloody. The quantity of blood and its character are very uncertain; a severe hæmoptysis is seldom observed (A. Frankel, J. Schwalbe), more common are small but frequently repeated bleedings, often of long duration, and resisting all methods of treatment. Very suggestive is prolonged bleeding with clear seroid sputum, a combination very rarely seen in tuberculosis. Very characteristic is a currant-jelly appearance of the sputum; the colour of the blood, which depends on greater or smaller alterations of the blood pigments, is of no value. The type of fever, when it is present, has no clinical importance, as it is due to different causes, such as secondary bronchitis, broncho-pneumonia, absorp-

tion from the breaking-down tumour, mixed infection of the necrotic tissue, &c. But the absence of fever of one of the tubercular types has some diagnostic value. A distinction may correctly be drawn between the cachexia of primary tumours of the lung and that of phthisis, and also that of abdominal malignant tumours, in that the first usually appears later, especially with the dissemination of metastases and the necrotic changes in the tumour. We have seen a patient improve during treatment in an institution and gain more than 20 lb. in weight, till he succumbed to a sudden, fulminating hæmorrhage. Metastases in the lymphatic glands may make the diagnosis certain, especially if they are multiple, grow quickly and are of hard consistency. Puncture of the lung has frequently revealed undoubted tumour elements.

Of our diagnostic aids, the tuberculin method takes the first place. The result of the cutaneous reaction is not of decisive importance; if a test tuberculin injection is not contra-indicated by the existence of fever, it should return a positive or negative answer; but at the same time in carcinoma reactions have sometimes been obtained. Here the possibility of a concurrence of cancer and tuberculosis is to be thought of. Hart has described a case of bronchial cancer, in which tubercle bacilli led a saprophytic existence in the stagnant secretion of the compressed tube. Such very rare cases may be delusive on the one hand by furnishing tubercle bacilli in the sputum, and on the other hand by giving a tuberculin reaction without specific tissue changes.

Radiography is of the greatest value for diagnosis; it seldom fails, and then generally only in the early stages of tumour; but difficulties may be caused by enlarged tubercular bronchial glands and extensive pleurisy. But a combination of all the other diagnostic methods at our command, with the important Röntgen-ray examination, should place the diagnosis on a sure foundation with few exceptions.

Hydatid Disease. Several of these points are also useful for the diagnosis of hydatid disease of the lungs. The subjective symptoms and the physical signs in the lungs are very similar to those of tumour. Spasmodic cough, ill-defined pains, sense of oppression, difficulty of breathing, loss of strength, blood-stained expectoration, even a large hæmoptysis may simulate tuberculosis. Here also Röntgen rays or the tuberculin diagnosis will clear up the difficulty in one direction or the other. Many authors warn against the puncture of the lung, in consequence of the danger of producing an asthmatical attack.

The contents of an echinococcal cyst are often expectorated, and make the diagnosis certain.

Actinomycosis. By the entrance of the mycelium into the respiratory organs an actinomycosis of the lung may be produced, and may simulate a slowly developing phthisis, on the one hand by the production of a pneumonic infiltration, and on the other by a destruction of the lung tissues. The correct interpretation of the initial symptoms is impossible; but as long as fever is absent a diagnostic tuberculin injection will exclude the existence of tuberculosis. As the disease advances, hectic fever, cachexia and amyloid degeneration usually occur. The diagnosis becomes certain if actinomycotic fungus is expectorated or discharged in the pus through a fistulous opening, produced by the extension of the disease from the lungs to the pleura and thoracic wall; for this the disease has a special tendency.

Difficulty of diagnosis caused by mediastinal tumours and affections of the pleura will be alluded to in the later sections on these diseases.

Pseudo-Tubercle Bacilli. The existence of the various pseudo-tubercle bacilli in the lungs and the means of differentiating them from the true tubercle bacilli have been mentioned under the bacteriological diagnosis. Whether these bacilli are harmless saprophytic parasites, merely important on the diagnostic side, or whether they, too, play a rôle in the pathology of the respiratory organs, there is a difference of opinion. At all events, more attention than hitherto should be devoted to these questions, since the pseudo tubercle bacilli exhibit a likeness to the true tubercle bacilli, not only in their staining properties, but also in their biological relationships.

4. PROGNOSIS.

To make general statements about the prognosis of pulmonary tuberculosis is only possible within wide limits and with many reservations and exceptions. We know to-day that phthisis is curable, and consider that this knowledge, based on a skilful, well-founded, therapeutic system, is the greatest medical acquisition of the last decade of the previous century. But the course and termination of the disease depends on so many elusive factors, that the prognosis, even in an individual case, is one of the most difficult problems of diagnosis. It is not always possible in the initial stage to give a definite decision, whether tubercular foci will become healed, or whether the disease will

end fatally after a longer or shorter time. This difficulty must be remembered in discussing prognosis. But, on the other hand, tuberculosis presents certain fixed types of disease which manifest themselves clinically in more or less characteristic forms, and in spite of their multiformity furnish valuable indications for prognosis.

The differences in the course of the disease depend on two factors, which equally affect the prognosis. There is first the nature of the infecting agent, the form and intensity of the primary infection, the virulence of the infecting organism, and the manner in which the infection progresses. The second factor is the constitutional sensibility and reaction of the patient, that is, the individual disposition of the infected organism in its widest sense. The formation of a prognosis depends on the correct understanding of the clinical peculiarities of individual cases.

As in all diseases, the prognosis is better the smaller the amount of disease; and the prognosis becomes worse the more extensive the mischief is, and the more unfavourable the conditions are for healing. We are therefore under the necessity of drawing distinctions between the widely different cases classed together as "phthisis," and to form them into groups according to the nature and severity of the disease and according to their different stages. Such a classification facilitates the formation of a prognosis.

Clinical Forms.

The practical necessity of a useful division of the disease into forms and stages doubtless exists, and has always existed. It is natural, from the many forms of the disease, that the proposals which have been made have not always been the same, but have varied according to the state of the scientific knowledge of the disease.

The usual classifications are founded on an anatomical and pathological basis. In the consideration of the histology of tubercle and the pathological changes in the lung tissue it was explained that the tubercle bacilli had a threefold effect on the tissues, cell proliferation and tubercle formation, exudative inflammation and necrosis. This triad of changes can be seen in every stage of the disease, only sometimes one or other change may predominate. According to the predominance of diffuse formation of new tissue with extension into surrounding areas, or of exudative inflammation succeeded by caseation and necrosis, the two well-defined clinical forms of fibrous and caseous phthisis can be separated from each other. On these two opposing tendencies influencing the march of the disease, the older writers founded their classification, and long ago recognized clinically

the "fibroid" and "colliquative" forms. Bechmer subdivided the second group into infiltration, large or small cavity formation, and spreading necrosis. This marks no progress; the three-fold changes correspond rather with the ancient classification of phthisis incipiens, confirmata and desperata.

Many divisions and groups were also made from the clinical point of view. Thus the disease was described as active or inactive, as latent, larval or manifest, as progressive, stationary or retrogressive, or as open and closed; or it was classified according to the predominant symptom into catarrhal, anæmic, dyspeptic, pleuritic, hæmorrhagic and febrile forms. The attempts at classification can hardly stand their ground against criticism, since they neglect too much the pathology of the disease. A practically useful classification must, as far as possible, consider the tendency in both directions; it must, on the one hand, be founded on an anatomical and pathological basis, and, on the other hand, it must sufficiently consider the clinical symptoms. To satisfy both claims the classification founded on the intensity of the progress of the disease will be of service: the acute form (miliary tuberculosis, septicæmic forms, and florid phthisis), the subacute and chronic forms (caseous, fibro-caseous, and fibroid phthisis), and the abortive form (a particularly mild variety usually localized in the apex), have been more especially distinguished by Bard. A sharp division between the different forms naturally does not exist and cases may pass from one class into the other, but this classification marks out the characteristic courses the disease may take.

Division into Stages.

Within this classification the most space is taken up by chronic lung tuberculosis, which is a mixed form of caseous and fibrous changes. From the excessive multiformity of this class of disease it is a recognized necessity to map out certain grades according to the changes that can be recognized by physical examination. The most general recognition has been accorded to Turhan's classification, which besides the intensity, specially considers the extent, of the disease. This is also the foundation of the Turhan-Gerhardt classification, which has been adopted for the purpose of unification of international statistics. It recognizes three grades:—

Stadium I.—Slight disease confined to a small part of one lobe, for example, in cases of disease of both sides not below the spine of the scapula, and the collar bone, in unilateral disease not below the second rib in front.

Stadium II.—Slight disease more extensive than I., at the

most the whole extent of one lobe; or in severe cases at the most affecting half a lobe.

Stadium III.—All cases above Grade II₂ and all cases with extensive cavity formation.

Under slight disease are included disseminated nodules, revealed by slight dulness, harsh, weak, broncho-vesicular breathing, with fine or medium râles.

Under severe disease are placed cases with infiltration, shown by more marked dulness, much weakened, broncho-vesicular or bronchial breathing with or without râles.

Extensive cavities, with tympanitic note, amphoric breathing, with coarse metallic râles, &c., come into Grade III.

Pleuritic dulness, if it is not more than a centimetre in extent, is not to be considered; if more, the pleurisy must be specially considered as a complication.

The grade of the disease is taken for each side separately. The classification of the case as a whole depends on the grade of the worst side; thus right side II, left side I = Grade II.

This simple and clear classification into grades has, in our opinion, in comparison with Turban's original scheme, this drawback, that it includes too much, especially under the head of Grade I, but also in Grade II. On the other hand it has the advantage of a separate heading for both sides. Corner with reason objects that a classification founded solely on the extent of the disease and on the physical signs has only a partial importance for the recognition of the severity of the case and its probable outcome, since it takes no account of the rapidity of the progress of the disease. However, it is easy to indicate on Turban's scheme by means of conventional symbols or signs whether high or slight fever, sputum containing bacilli, mixed infection or complications in other organs are present, so that the most important conditions affecting the prognosis can be easily recognized at the same time as the grade of disease. The chief thing is that, on the whole, the long desired agreement has produced at last a uniform classification into grades.

Acute Form.

The prognosis of the acute form may be dismissed with a few words. Miliary tuberculosis, the septicaemic form of pulmonary tuberculosis and florid phthisis progress, in the course of several weeks or months, relentlessly to a fatal end. The few accounts of these conditions resulting in recovery must be received with the greatest scepticism, and do not affect the unfavourable prognosis.

Subacute Form.

These conditions, which often begin acutely and progress afterwards less acutely, are generally forms of caseous phthisis due to aspiration, and have

a better prognosis. There are several forms to be differentiated; the caseous hepatization as the result of an hæmoptysis, the caseation as the result of changes in a small or large nodule, or in a large part of a lobe, in either case the result depending on whether the aspirated material is highly or less infectious. We refer here to the anatomical changes of caseous pneumonia, to its different transformations, and to its probable progress. These pneumonic forms are not always fatal, but may result after a severe conflict in excavation, connective tissue formation, and encapsulation, and under certain conditions even in slow reabsorption.

Abortive Forms. This form of pulmonary tuberculosis has the most favourable prognosis, as it is usually only very slight in amount, localized to the apex, and frequently heals quite spontaneously.

Chronic Forms. There is more scope for prognostic skill in the chronic forms of pulmonary tuberculosis. The prognosis first of all depends on the grade of disease at the commencement of treatment; which leads us to consider a little more the classification into grades. It depends on the amount of disease and its intensity, that is, it differentiates between slight and severe disease. The chronic pulmonary tuberculosis may be either a mixed form of slight fibroid disease, with circumscribed contraction and healing processes, or a severe caseous form with destructive tendencies. The prognosis is the more favourable the more the fibrous form predominates, the more limited the disease is to one side, and the more localized it is to a definite part of the lung; and it is more dubious and serious the more scattered the foci are, the quicker the infiltration occurs, and the more extensive and the more rapid are the caseating and necrotic changes. Processes localized in the lower parts of the lung have of course a worse prognosis on account of the tendency towards defective limitation and encapsulation.

The close examination and mapping out of the morbid changes with the help of all the refinements of diagnosis is a great aid to prognosis. The division of chronic lung tuberculosis into (1) slight, (2) moderately severe, and (3) severe cases, or with regard to their future tendencies into (1) favourable, (2) difficult to check but still curable, and (3) doubtful or unfavourable (no healing at all or relapse more likely), also serves the same purpose. Owing to the nature of the disease each grade can only be imperfectly marked off; and the deductions drawn from the pathological anatomy and from the clinical course do not entirely coincide. So that a strict division cannot be made between the individual grades, as need hardly be further explained.

The healing of an afebrile case of Grade III may take place more smoothly and quickly than that of a feverish case of Grade I with unfavourable localization of the disease. The idea that disease of the left lung on the whole is more unfavourable than that of the right we cannot confirm; on the contrary, owing to the favourable anatomical situation of the lower part of the anterior border of the left lobe, a high degree of contraction, and thus a favourable prognostic course, is observed much more frequently in the left side than the right (Turban). We will not allude further to the separate prognosis of the individual grades, the statistics on this point are of no value.

Two weighty factors, which together affect the prognosis, have already been mentioned, the severity of the infection, and the powers of resistance of the infected organism. The constitutional or natural resistance of the individual depends both on the resistance of the pulmonary and connective tissues, and on the vital energy of the whole organism. If the disease has already taken root, then its further progress depends on the capacity of the organism to react with the necessary forces for healing. Of the greatest importance for this is the functional capacity of the chief organs. With each complication, whether tubercular or non-tubercular, the prognosis deteriorates, and the more so the more important the function of the organ secondarily affected, the damage to the second organ sapping some of the strength required for withstanding the principal disease. Particularly far reaching, to mention only one example, is an affection of the blood and the blood-producing organs, in which the protecting substances against tuberculosis are formed. Accordingly there is a whole series of factors which influence the prognosis of chronic lung disease, in different directions.

Hereditary Predisposition.

An hereditary predisposition has importance for prognosis according to the general experience of the practitioners of the older school. According to Turban's statistics cases with an hereditary taint lived longer than those without, and those patients both of whose parents were tubercular even still longer than those only affected on one side of the family. According to the theory of Reibmayr not only is the pathological tendency transmitted, but also the powers of resistance acquired in the contest with the disease, which in the course of generations is raised into an immunity.

Constitution.

The prognosis depends in a definite way on the constitution. Usually the course of phthisis is more favourable in strong patients with a well-built

thorax, than in those of weak build; also according to statistics the duration of life is better in the first, and becomes more unfavourable the more marked the phthisical aspect. Just as certain diseases in the parent at the time of procreation, such as cancer, diabetes, general bodily weakness, old age, inbreeding, &c., are correctly considered as causes of hereditary predisposition, as are also the lifelong weakness and bad appetite from youth described by Brehmer, so these factors also play a part in prognosis, especially if they appear also in the individual himself. If the hereditary predisposition and the phthisical build, which is the outward sign of the inborn disposition, are both met with in one patient the prognosis is so much the worse.

Thoracic Measurements.

The phthisical thorax, as revealed by measurements and spirometric observations, also furnishes points of value in forming a prognosis. Although the measurements of the circumference and depth of the chest and of the capacity of the lungs are not of much service for the finer diagnosis of the functions of the lungs, yet, according to our results obtained from a large number of patients over many years, exact uniform measurements are of value for prognosis. The estimation of the vital capacity is more reliable than the external measurements, which only vary within small limits. A real increase of the vital capacity indicates re-absorption of infiltration; and as this does not mean exclusively an increase of the respiratory surface, but to an even greater extent a strengthening of the whole respiratory apparatus, such an improvement in the general condition of the lungs and thorax is of favourable prognostic meaning. With even more certainty does a diminution of the vital capacity indicate an increase in the tubercular lung changes, an objective sign which is of the more value as it may indicate new deep-seated foci which cannot be fully detected by physical examination.

General Health.

The state of the general health of the tubercular patient is not to be under-estimated; individuals, whose strength is undermined by disease, excesses, alcoholism, bodily and mental overstrain, frequent pregnancies, difficult labours, grief, privation, and other factors lowering in many different ways the resistance and nutrition, have a bad prognosis.

Digestion and Assimilation.

Particularly unfavourable are chronic affections of the digestive and assimilative organs. Regular appetite, a healthy stomach, and an unimpaired digestion are priceless gifts for the consumptive; they may defer for a long time the loss of strength,

and are the best indications of a favourable prognosis in long-standing disease. On the other hand a falling appetite and progressive loss of weight have always a sinister meaning. The more important diseases of the digestive organs and their prognostic importance will be referred to later.

Circulatory System.

Valuable information for prognosis may be afforded by the condition of the heart and circulation, particularly by the state of the pulse. The many claims on the heart during the varying course of chronic phthisis need a healthy muscle and intact valves. It may be noticed that just as defects of the mitral valve afford a relative defence against the onset of tuberculosis, by the induced congestion of the pulmonary circulation, so also, if met during the course of the disease, they are less serious than affections of arterial valves. The course of an already existing tuberculosis is but little influenced by accidental heart failure; on the other hand the effect of tuberculosis on the compensation of valvular changes is more unfavourable the more rapid the disease. In all considerable organic, functional, and compensatory affections of the heart it may fail in consequence of acute complications, and the summation of depressing influences such as toxins and fever. As the chief power of resistance to infection lies in the blood, so each morbid alteration in the blood affects the prognosis. The alteration of the white cells described by Arnet is of particular importance, since the polymuclear leucocytes are the chief carriers of the antibodies. The quite early diminution of the blood-pressure is of value for prognosis, as it falls more and more with the progress of the disease. Acceleration of the pulse has a similar importance. According to Turban a very changeable pulse, easily increased by slight psychical and other influences, calls for caution in forming a prognosis, and a constantly frequent pulse, even in the early stage, is an unfavourable sign. A close examination and registration of the pulse curve is therefore of value in all doubtful cases. A marked enfeeblement of the pulse, especially conjoined with undue frequency, is unfavourable, and is a sign of heart weakness often occurring quite early in the disease.

Sex.

The sex of the patient is without special importance for prognosis. The duration of life of men patients in public sanatoriums is less than that of women, but that is in consequence of their harder occupations; the prognosis of men in better positions is in no way more unfavourable than that of women. On the other hand the chances of women are lowered by the consequences of marriage, especially during pregnancy, child-birth, and the puerperium.

Age.

More important is the age of the patient. In infancy tuberculosis takes regularly a rapid, lethal course. With increasing age this lethal tuberculosis is proportionately rarer, and one meets unsuspected tuberculosis with increasing frequency, that is to say, the increasing powers of resistance of the organism of 7 years old and upwards diminishes the tendency to generalization, and increases the frequency of chronic and healed disease. With the supervention of puberty the tuberculosis of children approaches the adult type, the lungs are specially picked out. The resistance, however, is not yet so great as in adults, so that acute progressive phthisis is frequent at this age. In later years florid phthisis is rarer, and the prognosis becomes more favourable with age. At somewhere about 60 it gradually gets more and more serious, a substantial improvement in the lung disease will be rarely attained.

Duration of the Disease.

Of greater importance for prognosis than the age of the patient is the age and previous course of the disease. Herein lies the value of a careful history, and of a critical examination of the data thus obtained; it makes it easier to determine whether the case in question is advancing, stationary, or healing and retrograding.

Temperature.

In individual cases the most important criterion for prognosis is the temperature. Complete absence of fever may be seen in progressive tuberculosis and in terminal cases as a result of complete failure of the power of resistance, but it is nearly always a sign that the disease is at a standstill. The higher the fever is and the longer it lasts, in spite of absolute rest and suitable treatment, the less likelihood there is of a favourable outcome. But if the body-weight is maintained, or, at all events, if it does not fall rapidly, there is still ground for hoping the temperature will drop. Hectic fever, with high evening temperature and big morning drop, is very serious. The inverse and collapse temperatures are always unfavourable. A definite meaning cannot be given to the different types of fever; however, a mixed streptococcic infection plays a most important part in the production of continued high fever; tetragenus also has a very injurious effect.

Hæmoptysis.

The prognostic importance varies with the amount and frequency of the bleeding. Small hæmorrhages are generally without importance, indeed the favourable fibroid form is particularly inclined to bleed. Also contracting and distinctly healing disease may give rise to hæmorrhage. Hæmoptysis is not rarely the first sure sign of

the existence of phthisis, and so is indirectly favourable by making the situation clear, and it may have a valuable educational influence on careless and frivolous patients. Copious and frequent haemorrhages reveal a tendency of the disease towards destructive changes, and are serious, not only from the loss of blood, but more so from the great danger of caseous pneumonia due to inhalation of blood mixed with sputum and bacilli. Death from haemorrhage or suffocation is also possible.

Sputum. The examination of the sputum gives some definite prognostic information. The

amount of the expectoration is not of special importance. Acute processes produce as a rule little or even no sputum; copious sputum need not necessarily be due to tuberculosis alone, but weakens the patient through the often considerable loss of albumin. Progressive diminution of the sputum is a favourable sign. The existence of tubercle bacilli in the sputum is of importance, in so far as open tuberculosis is usually of more advanced grade than the closed form, and therefore in general has a more unfavourable prognosis. Of slighter value is the number of the bacilli; however, a constantly high number is a bad sign, and progressive diminution and total disappearance of bacilli is an important objective mark of improvement. There is a difference of opinion as to the meaning of the forms and staining properties of the bacilli, and of the presence of granules. We observe that cases with Much's granules in the sputum have a strikingly favourable course, an observation which agrees well with the view that Much's granules develop *out of* the tubercle bacilli as spores, being reduced to this change as an adaptation to unfavourable conditions for their life.

Reference has been made to mixed infection when speaking of fever. The presence of elastic fibres is a sure sign of an advancing, destructive process. An intracellular position of the tubercle bacilli is generally observed in cases progressing towards healing either naturally or under the influence of tuberculin. On the other hand the presence of eosinophile cells has no prognostic value.

Diazo-reaction. Much work has been done on the prognostic value of the diazo-reaction. The results are

that a transitory diazo-reaction is meaningless for prognosis, constant absence throughout does not speak for a good prognosis, on the other hand a persistently marked positive result is indicative, with few exceptions, of a progressive form of disease. But this is usually by then so obvious that it does not need to be shown by the diazo-reaction.

Tuberculin Tests.

The prognostic information given by the various tuberculin tests is still slight, but work is now being done on the subject. The conjunctival method is of no value in this connection, and the cutaneous but of little more, while a larger or smaller reaction to a subcutaneous injection of tuberculin permits a certain conclusion to be drawn as to the activity and intensity of the disease. In general it can be decided, apart from quite hopeless cases, with no sensibility to tuberculin, that both slight cases with marked tendency to healing, and also more severe stationary cases with markedly favourable progress of the disease, possess a raised power of natural resistance to tuberculin, which indicates a great capacity of the organism of withstanding tuberculosis. On the other hand newly affected cases show a very ready reaction to small doses of tuberculin. But whether in initial cases a high sensitiveness to tuberculin in the cutaneous or subcutaneous tests is to be considered a particularly favourable sign, and as evidence of a great power of reaction inherent in the individual, the results which have hitherto been obtained do not suffice to show.

Tubercle Bacilli in the Blood.

The discovery of tubercle bacilli in the circulating blood succeeds with greater frequency the more severe the tuberculosis and the nearer the end of the patient. In spite of this, a positive result has no prognostic significance, as it is also obtained in early cases of not excessively severe disease. The consideration of this subject is deferred to the section on "Tuberculosis and the Blood."

Serum Prognosis.

Opinions are not in agreement as to the value of the opsonic index for prognosis. A positive result, and still more an increase, of the agglutination phenomena give an important indication of the formation of specific products of reaction with immunizing qualities, either under the influence of general hygienic or dietetic treatment, or during a course of tuberculin. In individual cases, however, the reaction proves untrustworthy.

Lilje and Sturm have undertaken a series of observations on the serum reaction before and after specific treatment which should supply valuable information for the formation of prognosis. In spite of the difficulties in the way of an exact interpretation of the results of the experiments, owing to the variable course of tuberculosis, and the spontaneous appearance of specific reaction products in the serum, the authors could recognize that an increase in the amount of complement fixation was in most cases a favourable prognostic point; while the cobra-venom test,

the agglutination test, and the precipitation experiments, on account of deficiencies in the method, gave no useful results. But the indications for prognosis founded on the results of serum tests of the increase of antibodies must come after the consideration of the clinical factors of prognosis.

Complications. It would take too long to consider how the prognosis of tuberculosis is affected by every tubercular and non-tubercular complication; but the previous chapter will furnish many points of use to prognosis.

Particularly unfavourable complications are diabetes, alcoholism, and severe forms of exophthalmic goitre. In the chapter on therapeutics will be given information as to the influence of certain complications not only on the treatment but also on the prognosis. How tuberculosis of other organs affects the prognosis of phthisis may be gathered from the chapters on the separate organs.

Social Conditions. It is obvious that the prognosis of phthisis depends in a large measure on the means which can be employed for the cure of the patient.

So that there is also a social side to the question of prognosis. We will explain later in various stages of the disease what conveniently can be done, and what necessarily must. We will shew, too, that though the first and last part of the treatment of tuberculosis devolves on the family doctor, who must play an important part in any method of treatment, yet, for reasons to be mentioned, nearly all cases benefit by a removal from their homes in the critical period of the disease, and often enough such a change is absolutely necessary. Therefore it is a most important point in the prognosis whether this indispensable treatment away from the home of the patient can be commenced at the right time and be continued long enough. In this way the prognosis depends on the pecuniary position of the patient, which also very largely affects his conditions of life after the conclusion of the special treatment. But even for the less fortunate classes phthisis has lost its worst terrors by the organization of public institutions.

Character of the Patient. Lastly, the prognosis depends, to a large extent, on the behaviour of the patient himself. During the long and frequently

changeable course of the disease there will be many calls on the patience, judgment, and intelligence, and often enough also on the self-control and resignation of the patient while undergoing treatment and afterwards. Weak-minded, nervous, excitable, over-anxious, and fickle patients do not possess the qualities necessary for a satisfactory and lasting success in dubious cases.

and their prospects of cure will often be much less than those of serious, intelligent, and strong-minded individuals. Therefore the character of the patient plays a part in the prognosis of phthisis, and, indeed, not the smallest part.

5. TREATMENT.

For the treatment of pulmonary tuberculosis, wherever it is carried out, there are two main factors.

The first is essentially a constitutional treatment. We understand by the constitution of the patient the whole of the vital changes that are perceptible to the physician, so that the essence of constitutional treatment is to restore disordered functions to their normal state. Owing to the particular importance of the lungs in connection with the gaseous exchanges any disturbance of their functions, which are of primary vital necessity, will derange the working of the nervous system, the action of the heart, and the economy of the whole organism; so that pulmonary tuberculosis interferes not only with the working of the respiratory apparatus but also with the functions of the whole organism, both bodily and mental. The treatment, therefore, must be both physical and psychical; physical, to restore the proper working of the tissues and organs; psychical, to act on the mind of the patient by guiding, instructing, and educating him.

In the second place the treatment must be adapted to the individual patient; his bodily and mental peculiarities must be grasped by the doctor, and a plan of treatment founded on knowledge and experience devised for this one special tubercular person. It therefore follows that the treatment of pulmonary tuberculosis consists of physical and mental treatment of individual tubercular cases.

Brehmer and Destoulier performed the great service of building up the principle of individual constitutional treatment on the foundation of general hygienic and dietetic therapeutics.

I. General Hygienic and Dietetic Treatment.

All treatment of tuberculosis is based from beginning to end on general hygienic and dietetic treatment; which must, therefore, form a part of every method of cure. On the other hand, one must not overlook the fact that it is only one link in the whole system, and that it is always a mistake to tear one method from the united whole and to proclaim it the method of curing consumption.

**Psychical
Treatment.**

We begin with the psychical treatment, being of the opinion that "a bad psychologist can never be a good lung doctor" (Cornell).

This psychical treatment is more or less deduced from physiological conditions, and is necessary, as the patient must have his will power and endurance encouraged for months and often for years; he must live conformably with the doctor's orders, he must follow rules of moderation and must change his prejudicial habits, often enough deeply rooted. First of all the patient must be educated. The course of treatment must be written out for him in every detail, and the utility and reason of the orders clearly explained in an intelligible way, for "every rule is better imprinted on the mind and enforces itself more fully in the obedience if supported by a reason that can be clearly understood" (Dettweiler). Rules as such are not necessarily obeyed, but if they are first understood they will be conscientiously carried out. Besides the rules of treatment, the most conscientious and cautious cleanliness in dealing with the expectoration must be impressed on the mind of the patient.

Very important, even necessary, is the instruction of the patient as to the nature of his disease. He must, as long as he is not hopelessly ill, be told the truth. For never will he see the necessity of irksome rules and of wholesome constraint of his whole manner of life, if the full seriousness of his condition is not explained to him. The unfortunate terms "catarrh" and "weakness" of the lungs must never be used in reference to pulmonary tuberculosis; they only lull the patient into a dangerous carelessness, for which he will later suffer. At the same time, it is naturally wrong to exaggerate the danger. Most tubercular patients are impulsive, nervous weaklings, who, on a warning of merely "lung weakness," are not inclined to give up even one of their injurious habits, but who, on the hint of consumption, can more or less restrain themselves. Nowadays a verdict of tuberculosis is no longer a death warrant, and an exposition of the powers of therapeutics may remove many difficulties. What else can be said to each individual patient must be left to the tact of the doctor, who will act as he thinks fit. In hopeless cases medical frankness must give place to merciful evasions, for truth would here be cruelty. On the other hand, even a curable patient must be informed, if not at the first consultation, then later on, that he is suffering from a serious illness, from which he can recover only by following the doctor's orders, and co-operating with him while leading a fixed and regular course of life. The comprehension of the nature of his disease,

the hope of recovery and the conviction of the necessity of the requisite treatment, are stages in the education of the consumptive.

The education of the patient also includes the acquisition of faith in his doctor and in medical science, which he must retain through the good and bad days of his chronic malady. As a rule, it is not difficult to persuade the frequently impulsive, but usually good-natured, consumptive, what he must do, and what he must leave undone. A certain severity on the doctor's part against frivolity, benevolence towards ignorance, and a warm but restrained sympathy for all, are pre-eminently helpful factors in the educational-psychical treatment.

Mental disturbance and unrest are harmful, and should, if possible, be obviated; we need only recall to our mind the rises of temperature and attacks of sudden haemoptysis which may follow emotional outbreaks. On the other hand, complete idleness and mental apathy are not the right things. We should, therefore, urge melancholy patients to light amusements, such as draughts, halma, dominoes, and chess; or to interesting books, music, discussions, garden parties, &c. Card games may be permitted if not played for money. Reading, at least in young patients, must be strictly supervised; so-called popular medical works are not good, as they may cause mental disturbance and prolonged agitation.

Physical Treatment.

In the physical treatment the two chief things are the management of the rest and exercise, which may be applied to the whole body or to the diseased lung itself. Under the first heading we have rest and exercise in the open air; under the latter we have breathing exercises and methodical deep breathing. In these matters we find great differences of opinion; while there are some who lay great stress on the exercise, and others who think more of the rest, the correct method lies in regulating the two for individual cases; but rest must take the chief place.

Open-air Cure.

The open-air cure includes both rest and exercise in the open. For it no special altitude or climate is necessary. The important point is the freshness of the air and its freedom from dust, gases and organisms. The purity of the atmosphere increases with its distance from human habitations, and its freshness with the amount of exposure to sun and wind. Excessive direct sunshine, damp thick fog, and keen east winds are not desirable for the open-air treatment. The patients must be sheltered from them, as also from rain and snow and rapid alterations of temperature.

Rest Cure.

This consists in lying out in the open air.

The patient spends his day out in the air in convenient shelters, warmly clad, and with his muscles relaxed. To spend the day in this way and the night in an airy bed near an open window is to fulfil the conditions of a continuous air-cure. Open halls, pavilions, balconies, verandahs and shelters protect against direct sunshine, rain and wind, and make the open-air cure possible on every day and at every season of the year. Private institutions, which receive more severe cases who cannot go out, should have open halls, which can be heated and into which the febrile patients, still in bed, can be moved; costly but very necessary constructions, which we particularly recommend. Halls and shelters can generally be arranged with a little trouble in the woods and gardens for short rests. In good weather the treatment can be carried out under the open sky, and in hot weather under trees.

Iron couches with mattresses and movable backs are the most useful; fixed backs are not to be recommended, as rest in a horizontal position with the head only slightly raised is often desirable. Recently Jacoby has condemned the usual half-sitting position during cure, as it induces anemia of the apices of the lungs, which according to both ancient and modern views is conducive of tuberculous of that region; this has been our opinion also for many years. Jacoby goes still further and altogether forbids the semi-reclining position; he places the thorax flat, with the pelvis raised on an adjustable elevator. The abdominal organs are thus pressed up against the diaphragm, compelling a deep costal type of breathing, and by compression of the lower lobes forcing the blood into the upper part of the lungs, and producing a relative hyperemia of the apex favourable to cure.

Hammocks and canvas folding-chairs are not suitable, as they cause compression of the thorax, instead of allowing free and easy breathing. As protection blankets may be used, and in winter furs or sacks, some of the latter being desirable.

The rest cure is to be strictly carried out at the appointed times and in the appointed way. Patients who are sitting up, or running to and fro, or lying on their sides reading, or drawn up over some work, are not carrying out the treatment; for a most important part of this is directed towards rendering the lungs hyperæmic by rest in an almost horizontal position. The duration of the cure hours must be settled for each individual patient, according to the state of his lungs, his digestion and his heart. For afebrile patients of the first and second grades from six to eight hours are necessary, divided into periods of $1\frac{1}{2}$ to 2 hours in the morning, afternoon and evening; with steady improvement half of this will be sufficient; but slightly febrile, or anæmic patients, also those with much cough, must rest the whole day. These latter cases should have systematic

passive movements, or, better still, massage of the extremities and trunk, to overcome the sluggish circulation induced by absolute rest. Very sensitive or weak patients must be gradually accustomed to the open-air treatment; they should be brought into the house at sunset, and not be exposed to the night air till they are fully acclimatized.

What are the advantages of the open-air treatment? The prolonged exposure to the unrestricted light and pure air in all weathers counteracts many of the effects of tuberculosis, especially the wasting, the toxic heart weakness, the catarrh and the fever. Further, the daylight and sunlight stimulate the cellular tissues, strengthen the organic functions, facilitate the excretion of carbonic acid, stimulate the blood changes, and restore the impaired action of the skin. There is an increase of energy, and the patient is hardened, strengthened and tranquillized. The heart beats more steadily and strongly, the appetite and body-weight improve, night sweats disappear, the slightest grades of fever are removed, the sleep is more peaceful, and the feeling of general well-being is augmented. Improvement in the lung condition goes hand in hand with this, the cough becomes less, the expectoration diminishes, and the breathing becomes altogether more free.

Jacoby observed after rest with the chest horizontal and the pelvis raised, that in a much shorter time the breathing became deeper, the cough less, the expectoration loosened and then ceased, and especially the pains in the chest and back disappeared. We agree that these results are possible, but from our own experience must make the reservation that the "auto-transfusion" position of Jacoby, even if the lowering of the thorax and raising of the pelvis are cautiously and gradually done, cannot be continuously and systematically employed for all patients, and not even for the greater majority. Many patients refuse at once from indolence or other unreasonable considerations; but not a small number of those who carefully follow all the rules after rest in this position suffer from cerebral and general congestion, which more than counterbalances any useful hyperæmia of the lungs which may have been induced. In spite of this we hold with Jacoby that it is scientifically correct to try and induce some hyperæmia of the lung during rest cure. It must be attempted by encouraging rest in a completely horizontal position, and when this is well borne the foot of the couch may be slightly raised; the horizontal position at least being absolutely insisted on. The benefits of the rest cure are frequently not sufficient by themselves; and outside the sanatorium they are almost entirely valueless.

Exercise.

With increasing improvement in the lungs and the general condition there is an impulse on the part of the patient towards exercise, which may be utilized under careful supervision. It must be remembered that the consumptive is a weakling whose duty it is to save his strength. Brehmer's old rule very truly said "the healthy man sits when he is tired, but the consumptive must sit that he should not become tired." We may begin by permitting two to three walks a day of a quarter to half an hour's duration, on level ground, at an easy pace; but in every case the amount of movement must always be controlled by observation of the temperature, pulse, heart and general condition. One patient will require more rest, another more movement; as a general injunction, "Go for a good walk" is almost more absurd than "Lie a lot in the open air." If all signs of reaction are absent the rest may be shortened, and the walks lengthened to one or two hours, still forbidding much hill climbing, especially for strong, quite afebrile patients with localized disease, and in a good state of nutrition.

The walks must be finished in good time, so that the patient can still have a quarter to half an hour's rest before meals; this will facilitate the digestion. After the midday dinner, rest, with or without sleep, is always required, unless the patient is a well-nourished, heavy eater, who should not put on more weight. In summer the early morning and late afternoon hours are to be preferred for long walks; in winter the later morning and early afternoon; they are not to be given up for unfavourable weather, such as wind, light rain and snow. In severe rain, tempests, storms and heavy snowfalls the patient must not go far from the house. He must always walk with an upright carriage, and take care to breathe evenly through the nose. In steep places he must walk more slowly, and must stop or turn if the breathing and heart action become accelerated.

It cannot be doubted that the amount of rest ordered by doctors was previously excessive, and perhaps is so still. Dettweiler, who introduced the rest cure, has himself spoken against excessive rest and in favour of more exercise. But the contrary opinion, that lung tuberculosis can be cured quite without rest by means of exercise and work, is equally unfounded. The broad, middle path must here be followed and the correct "dose" of exercise carefully prescribed, drawing distinctions between wasted and corpulent patients, between febrile and afebrile cases, between early and chronic third-grade cases, and between a tubercular diabetic and one with an affection of the heart. The way the nervous system reacts to rest and movement must also be con-

sidered. Patients, who on the rest couch are nervous and neurasthenic, may have their rest hours broken up by more exercise, if the state of their lungs allows it.

No general rule can be made on the question of permitting exercise in the form of games, sports and physical labour. When long walks, especially uphill, are well borne, lighter work in the open air cannot be harmful. We also think that it is useful to systematically habituate to work those who must soon return to arduous occupations. We lay less stress on the still undetermined "auto-inoculation" produced by more severe work than on the psychical stimulus of knowing that the power of work is returning. Under similar conditions croquet and skating may be permitted, but lawn-tennis, bowls, gymnastics, cycling, rowing and dancing must be forbidden if the disease is still active. Riding and tobogganing are on the border line, they may be allowed if the patient knows how to be moderate. In general the doctor should take the line that much care and prudent exercise is the best for his patient.

Air and Sun Baths.

Recently it has been proposed to combine air and sun baths with the rest cure. The sun-bath is given in many different ways, which cannot be described here in detail; in consequence of the direct action of the sunlight its effect is more marked and more severe than that of the air-bath. If the prejudice against the use of sun-baths in tuberculosis has been removed, there still remains the doubt as to their action apart from the necessary exposure to the air, and whether their effect is due to the warmth of the sun only, or to the intensity of the light, and whether the tissue-penetrating yellow and red rays are as powerful as the blue and ultra-violet, which owing to absorption have only a quite superficial action. It is quite certain that the sun-baths stimulate tissue changes. Therefore they may be recommended for the heavy, pasty consumptive, who is corpulent or tends to become so. Prudence and caution are, however, required, as sun-baths may produce rises of temperature from 2° to 3° F., or more, cardiac irregularity, and increased irritability of the nervous system. They are contra-indicated in advanced neurasthenia and in cases with a tendency to fever or hæmorrhages. The head must be protected, and the duration of the sun-bath must not exceed half an hour.

Air-baths act on the skin by means of the air and light; they influence the heat regulation, lessen nerve irritation and increase the perspiration. The results are stimulation of the phagocytic action of the cells, increase of tissue changes and of

the appetite, strengthening of the heart's action, and of the respiration, and diminution of the expectoration. The air-baths also harden and strengthen the patient, and have a beneficial action on neurasthenic and anæmic individuals, if commenced with care. Apart from the general hardening, they improve the constitution and remove secondary catarrhal conditions. Hemorrhages and temperature rises need not be feared, only the bath must not be prolonged for more than ten to fifteen minutes; also they must be commenced with caution at certain seasons of the year. At unfavourable seasons air-baths in the room, lasting from ten to eighteen minutes, accompanied by physical exercises, may be recommended, but only on the doctor's orders.

More necessary and important is the permanent air-bath, in the sense that permeable clothing and coverings should allow, both by day and night, a constant interchange between the air surrounding the body and the outer air. Without chilling the body this will facilitate the action of the skin, and diminish the perspiration. On these grounds corsets must be forbidden, and also thick feather-beds and heated bedrooms.

Lung Gymnastics.

Exercise and movement of the lungs by means of lung gymnastics requires adroit and vigilant individual management to avoid excess. We do not share the fears of those over-cautious physicians who see in every deep breath a danger of drawing bacilli into the deeper parts of the lungs. If this were so all therapeutics would be useless, since unintentional deep breaths are inevitable. Neither can we agree with those who attempt to eliminate from the body the diseased parts by means of injudicious exercises, on the ground that the sooner the affected part is removed the better for the organism. This is a dangerous doctrine; since early processes may become healed without loss of substance, and a rapid separation of the diseased part, even if it is successful, is not desirable. Mechanical irritation of recently inflamed tissue will cause an increase of exudative and destructive changes, augment toxic absorption and infallibly end in hæmorrhage, fever or heart disturbance. The recovery of tubercular lungs and of the whole organism can only take place by a process of regular, slow development. Therefore it is better that necrotic tissue should be slowly removed, and the still unaffected surrounding areas strengthened, not roughly and rapidly, but by methodically weighing and proving each step. Only thus shall we avoid the bitter experience of having to attribute to the progressive character of the disease bad effects, which are really due to unsuitable and carelessly applied lung exercises.

However, in cases which have come to a standstill under treatment, and in which the fever, expectoration and cough have disappeared, it is well from time to time to vary the rest treatment with exercises. This may be done by regular, methodical, deep breathing, inspiration taking place slowly and steadily through the nose without over-distending the lungs. This is followed by a rapid, jerky expiration, which may be assisted by pressure of the arms on the chest. But the patient must be informed that movements of the arms alone, without attention to the method of breathing, are useless. Naturally these exercises require constant control.

Simple deep breathing in the open air is sufficient: apparatus for respiratory gymnastics are superfluous in consumption. As much as we dare attempt to do, that is, to improve the nutrition of the still healthy tissues by the necessarily increased blood-flow, and to raise the blood and lymphatic flow through the diseased areas and their surrounding parts back to normal, we can achieve with exercises without apparatus. An increased flow of air through the lungs goes hand in hand with an increased flow of blood. It is obvious that lung exercises may also be regulated by means of walks, especially by mounting gentle inclines.

Treatment by Baths.

Treatment by means of baths is the second method of physical treatment. The treatment affects the general health, and may be employed to a greater or less extent, according to the local and general state. It mechanically purifies the body, it educates the patient in the value of cleanliness, it promotes the natural functions of the skin, and so raises the powers of resistance of the organism against infection. These measures of hydrotherapeutics are efficacious in stimulating the nerves in the skin, strengthening the action of the heart, diminishing the peripheral resistance both in the systemic and pulmonary systems, improving the state of the blood, deepening the respiration, facilitating the exchange of gases, regulating assimilation and nutrition, and improving the digestion and appetite.

Consumption is a disease of the skin, in so far as the physiological skin breathing is disturbed. For the purpose of restoring this function a hot bath at 92° to 95° F., for five to ten minutes once or twice a week is useful: plenty of soap must be used to get rid of perspiration, grease, scurf and epidemic scales. After the bath a cool douche of 68° to 80° F., or a tepid sponging, followed by careful drying, should be used. Slightly febrile patients should take their bath in the morning

as the time freest from fever, and should then go to bed. Patients with temperatures of 100° to 102° F. generally stand the bath well, if the heart is in good condition. Köhler observed, even after a hot bath of 105° to 108° F., a fall in the temperature, and recommends hot baths for febrile patients, if there is no contra-indication, every two to four days, according to the reaction, but not every day. We have not observed this immediate effect of hot baths on tubercular fever, and do not recommend them for very febrile and advanced cases more often than once a week; and employ instead dry rubbing of the whole skin till it becomes red every morning. For preventing the perspirations we use every morning or evening partial or complete sponging with vinegar, alcohol, or aromatic spirits of ammonia 70 parts, sea-salt solution 20 parts, and eau-de-Cologne 10 parts.

The skin of the consumptive is also affected as regards the power of adjusting the cutaneous vaso-motor system to the changes of temperature of the air. Thence comes, apart from the affection of the lung, the peculiar liability to catch cold, which is a pathognomonic sign, even in quite early stages, and lasts throughout the disease, especially in acute cases. The hardening of the skin by means of baths is therefore very important. We must, by means of a careful and lengthy employment of baths, bring up the thermal resistance of the whole skin of the consumptive to the level of that of the laic (Winternitz).

For the treatment by baths it is necessary that the details be adapted to the individual susceptibility of the patient. The patient may feel the effects of cold, with bath temperatures only a few degrees below the indifferent point. The bath should be taken when the patient is warm either naturally or after rest in bed, exercise, or a warm breakfast; it should be short and should not chill the patient, who should feel braced up and invigorated. One a day is generally sufficient.

A simple form of treatment, that can be applied anywhere, is moist friction and partial washing in bed in the early mornings. The chest, back and extremities are quickly rubbed down with brisk movements of a bath-glove or towel soaked in spirit or water, and afterwards dried with a rough towel. One part after the other being exposed to the cold water in this method the total effect is mild. The patient is to remain in bed for some time after the rubbing down. Rubbing down with cold water is infinitely to be preferred to lukewarm washing, because after the latter there is no comfortable warm feeling, as after the former; also a tonic effect on skin, vaso-motor, and circulatory functions is hardly to be obtained with tepid water. For

advanced or weakened cases we order a rubbing down with spirit after the cold-water friction.

As the strength increases one can employ more severe moist friction of the whole body. The completely naked patient lies outside the bed, and is rubbed down by sharp strong movements of a damp sheet thrown over his shoulders, either cold water or 5 per cent. salt water being used. After this the patient is enveloped in a dry sheet and well rubbed. The whole process lasts one to two minutes. The water at first must be of a temperature of 75° to 85° F., and can gradually be reduced to 55° to 65° F. The patient may dress immediately after this, or go back to bed for a quarter of an hour. The action of this method consists in the contraction of the peripheral vessels by the stimulus of the cold water and their subsequent dilatation after the rubbing.

A more marked stimulation may be obtained by hot Sitz baths with cold douche on the upper part of the body, increasing in force, to be followed by dry rubbing. They must only be employed for fairly strong patients, whose powers of reaction are still good; they are contra-indicated for anemic cases. Perspirations, cold feet, headache and sleeplessness may be treated by hot or cold footbaths or foot douches; for this purpose it is best to begin with hot water and finish with cold, so producing a maximum effect on the vessels. Short cold Sitz baths after massage to the body are often of great service against the chronic constipation of consumptives. Arm and hand baths will be found useful for perspirations, for cold hands, and for feverish patients.

The most energetic form of hydrotherapeutics is the spray, jet or needle douche, to be followed by energetic rubbing and a walk. It must be decided for each individual case which douche to use, whether it lasts for five, ten or fifteen seconds, and whether it should be tepid (68° F.) or cold. It must be reserved for strong patients in whom prolonged observation has shown that the disease is stationary or healing; in winter special caution must be taken in ordering the length and temperature of the douche. With proper precautions the patient need not be afraid of bad effects. A good skin reaction and a subjective sense of well-being are signs that it has been well borne. The douche should be taken immediately after the night's rest, or better still, after breakfast; in the former case it is better with delicate patients, especially women, to give a glass of warm milk before the douche, which will assist the skin reaction.

Lately the hot douche has been employed in the form of a

jet of water at 104° to 120° F. directed from three or four yards off on to the principal seat of disease. The duration of the douche must be short, and the temperature of the water maintained throughout. It is beyond doubt that the hot douche removes pains in the chest, deepens the respirations, and loosens and diminishes the expectoration; it may therefore be indicated for certain cases of desquamative pneumonia, difficult expectoration, and advanced cases. But it can never take the place of the cold douche, which remains for stationary cases the means of hardening *par excellence*. According to our experience the hot douches can be dispensed with; not so, however, the cold and tepid shower and needle douches. The strong stimulus not only to the organ directly attacked, the skin, but also to the muscles and their vessels, causes a change in the blood distribution of the whole body. Also the contractions of the heart are strengthened, the tissue changes stimulated, and the breathing accelerated and deepened. It follows from this that the douche must not be used for febrile patients, for those with active disease, and for weak, anæmic persons. The colder the water, the greater the amount of water used, and the higher the pressure the more energetic, naturally, will be the skin and general reaction. It is not rare for strong and well nourished persons to react too much to the douche; it may cause dizziness, great exhaustion, and more or less severe headache, sufficiently severe to prevent a repetition of the treatment. The headache can generally be prevented by tying a wet cloth round the forehead before entering the douche.

Therapeutic measures even more valuable than those just mentioned are the regulated chest packs of Winternitz. They can be applied by a chest bandage or by several towels joined together.

According to the directions of Winternitz, an 8-in. bandage about 7 or 8 yards long is dipped in cold water and wrung out. It is carried round the chest, passing alternately under one arm and over the opposite shoulder, the rest of the bandage being carried circularly round the lower part of the thorax. Over this a dry flannel bandage can be wound. If delicate and anæmic patients are treated it is advisable to rub the skin well beforehand with alcohol and water, and also to place layers of waterproof stuff between the turns of the bandage, which retards the heat and is particularly serviceable for pains in the chest and for promoting the absorption of pleuritic inflammatory products. Irritation and redness of the skin sometimes compel frequent removal of the packing.

The packing is ordered for the night. By those staying in bed they may be used also every three hours during the day, or in afebrile cases every five to six hours. At every change of packing the skin must be dried and rubbed till it glows.

The followers of Winternitz give a physiological explanation of the action of the packing on the respiratory organs and whole body. In the first place the packing during the night quiets the movements of the chest, and therefore also of the diseased lungs, and in the second place it acts in a tranquillizing way on the whole organism, without having any drawbacks; the distressing cough, and the irritation of the air passages will be lessened, pains in the chest and side alleviated, and sleep will be easier and deeper. As a consequence of the undisturbed sleep, quieter cough, and painless breathing there is the desired loosening and facilitating of the expectoration of the accumulated secretion, especially if, after the bandage is removed, the chest and back are strongly rubbed with cold water. If it occurs in the morning directly after waking the easy expectoration is followed by a long salutary rest. The action can be still further increased in pleural affections by pouring alcohol on the damp bandages, which increases the hyperæmia.

The use of hot chest packs, instead of the cold bandages, may be desirable for patients who at the same time are suffering from rheumatic pains, and for those who are so anæmic or badly nourished that they become chilled and not warmed in the cold pack. Simply placing damp towels on the chests of recumbent patients is not to be recommended, as they are easily displaced and may cause chills. Other partial packs may be ordered at any time. It is better not to employ general cold packs as they may raise the temperature to the point of fever, and increase the work of the heart.

Dietetic Treatment.

The dietetic treatment consists principally in providing the consumptive with suitable nourishment. Nourishment is of the first importance for the progress of the patient on account of its direct influence on the condition of the body. Just as the loss of weight is one of the first clear evidences of tuberculosis, so from a purely empirical standpoint an increase and maintenance of the weight is distinctly a favourable sign. "As the digestive organs are one of the first lines of defence against tuberculosis, so also are they one of the most important factors in the healing of that disease" (Dettweiler). It has been shown both physiologically and clinically that with a raised state of nutrition the condition of the blood improves, the blood corpuscles increase, the action of the heart is regulated, and the powers of resistance of the tissues become and remain greater. As the circulating blood possesses more or less powerful protective bodies for the lungs, and antitoxic and antibacterial elements

which can resist the tubercular infection, so every improvement in the general state of nutrition will directly oppose the exciting causes of the disease. In this sense the increase of body-weight is of value as a sign of the raised resistance of the organism. The question of nourishment becomes the keystone of treatment, if tuberculosis of the lungs in its constitutional result of malnutrition corresponds with starvation of the tissues, as Brehmer and Dettweiler have always emphasized.

The attempts to influence favourably the tissue changes of consumptives have, however, nothing in common with forced overfeeding, the inconsiderate stuffing, which for many years has passed as almost the only weapon against tuberculosis. We know to-day, to mention only a few points, that the introduction of large quantities of albumen, especially of animal albumen, not only fails to increase the powers of resistance, but may in weakly constitutions produce further harm from the excessive work thrown on the digestion and from the formation of toxic by-products. It is not in accordance with sound therapeutics to order a consumptive with flabby heart muscles to drink as much milk as is possible, simply because it contains all the necessary foodstuffs in a comparatively digestible form; to supply the requisite number of calories something like seven or eight pints a day would be required. All excess of fluid not required by the body produces sensation of fullness and discomfort, and in sensitive patients disturbances of respiration and of the heart's action, without offering any nutritional advantage worth mentioning. In fact excessive nourishment of consumptives up to the point of corpulency is no advantage but a disadvantage, because it throws increased work on to the lungs, which would be better without it; and in any case the acquired fat is very easily lost and does not protect against relapses. Rapid and excessive formation of adipose tissue is particularly disadvantageous when there is much diminution of the respiratory lung surface, as occurs with marked fibroid or destructive changes in the lung; the dyspnoea on exertion is increased, and fatty degeneration of the heart favoured.

Therefore the dietetic treatment of the consumptive must also be adapted to individual cases. We must strive to obtain the optimum and not the maximum nutrition in each case, not to overload the body with fat and water, but to increase the capacity for work by improving the blood and the muscles; not to increase the quantity of the cells but to raise their quality and energy. This aim is soonest attained by a suitably varied and prepared diet, avoiding excesses either of animal or vegetable food, and paying less attention to its caloric value than to avoidance of sameness.

The mixed diet must contain all categories of foodstuffs, albumens, fats, carbohydrates, and salts. As this gives a very wide range it is possible to supply the requisite number of calories in many different ways.

The tubercular adult requires, in order to supply a balance towards a gain in weight, about 3,500 to 4,000 calories; that is 100 gram. of albumen supplying 400 calories, 200 gram. of fat giving 1,800 calories, and 400 gram. of carbohydrate producing 1,400 calories, altogether about 3,600 calories.

According to recent researches the minimum of albumen should be 30 gram. a day. But there is not the least ground for limiting the consumptive to this amount. On the contrary, Rubner maintains even for the healthy "that more than the margin of safety is necessary." Albuminous foods include meat, poultry, game, fish, and eggs; meat and eggs being particularly valuable.

Apart from its caloric value meat claims a large place in the menu, as it is richer than any other food in substances stimulating the palate, the heart, and the nervous system. But in our estimation of the value of meat we need not go so far as is done in Paris, where there are still to-day special dispensaries for zymotherapy, that is, for the treatment of the tuberculous with the raw flesh of such animals as are not subject to tuberculosis. We can also do very well without the use of large quantities of fresh ox-blood as a food (200 gram. mixed with milk or wine). The use of large quantities of meat in any case requires a good digestive state. Hoppe-Seyler considers its use justifiable in the chronic, more fibroid varieties of phthisis.

Eggs possess a high nutritional value, and can be placed before the patient in an agreeable and appetizing form, or may be added to other solid or liquid foods. Still the addition of half a dozen eggs to a meal already sufficient in itself, as is sometimes done, is a gross error, which the doctor must oppose. In cases of poor appetite it is advisable to use only the yolks, which contain two-thirds of the nourishment; they can be added to liquids and soups, or may be beaten up with a little lemon-juice, sugar, cognac, or wine. Three, or at most four, eggs may be used in cases in which the appetite is very bad.

Fats play a special part in the nourishment of consumptives, especially if there is much wasting. The form in which the increased quantity of fat is introduced depends on the habits and inclinations of the patient, as well as on the climate and season of the year. It is now understood that the cod-liver-oil treatment, so popular of former years, is only possible in the winter, and

generally only with children. Adults dislike taking the oil regularly, and it often does not suit them in summer. Fat bacon and meat, also suet, may be taken by adults in the more northern climates. Specially prepared dishes with much fat soon become repugnant, especially if the gastric secretion is deficient. The quantity of fats may be with more advantage supplied in the form of good butter, milk, and cream.

Butter may be plentifully used in the preparation of meat, flour and egg dishes, and in soups; it is also always easily eaten with bread. Milk, as an addition to the diet, is rightly much valued. If only about half to three-quarters of a pint of milk is taken at breakfast, lunch, in the afternoon, and at bed-time there is no fear of producing digestive disturbance; always provided that it is taken by mouthfuls, and that the milk is above suspicion. Boiled milk is better than raw, as it is easier to digest and safer. The unpleasant taste that many patients find in boiled milk can be removed by the addition of a little salt or lime-water, or in exceptional cases, of brandy. Milk can also be taken with an equal quantity of mineral water, or with one of the prepared foods, or as bread-and-milk. To the well-known preparations *kefir* and *koomis* has been recently added *yoghurt*, which may be recommended as a substitute in cases of aversion to pure boiled milk. As cream has three times the caloric value of milk it is sufficient to take a quarter of a pint of cream in the day, in order to considerably increase the nutritive value of a meal without appreciably increasing its bulk.

The importance of carbohydrates as an article of diet for consumptives lies in the fact that they can be served in a variety of ways, and prevent an exclusively, or too preponderatingly, albuminous diet. Further, in cases of aversion to meat, they form with fat, especially butter and eggs, a very valuable food-stuff. Peas, beans and lentils may be recommended in the form of soup, when, however, they soon induce a feeling of repulsion; or better as cooked vegetables with meat. The various forms of breads, biscuits, soup thickenings, macaronis, vegetables, and puddings may be just mentioned; some of the latter are valuable with fruit juice if the action of the bowels is sluggish. Potatoes should be served in one form or another with every meat course.

Vegetables of all sorts are of great value in cases of consumption, as in the other chronic diseases. Asparagus, spinach, cauliflower, and carrots may be specially mentioned, and if the digestion is good the various kinds of cabbage. The question of the dietetic use of their mineral contents is not yet thoroughly understood, they seem to have no special significance in tubercu-

losis. A suitable quantity of vegetables supplies that amount of indigestible matter needed for the mechanical work of the bowels, and prevents them from becoming torpid.

Salads and fresh or cooked fruits have a similar importance for the regulation of the bowels; one or other should never be lacking.

Artificially prepared foods can never replace natural foods. They have their place, however, when the intake of food is reduced, on account of the more concentrated nourishment they contain. The artificial meat preparations can be quite excluded, as they act as stimulants rather than foods, and a similar effect can be obtained as well, and more cheaply, by home-made beef-tea. Tripton, containing 90 per cent. of easily assimilated albumen, is much to be recommended. Amongst the casein preparations we may mention sanotogen, plasmon, nutrose, and eucaine; and of the vegetable albumen preparations, reborat. They are considerably cheaper than peptone, which supplies albumen in an already prepared form to patients with deficient hydrochloric acid secretion; Lirbig's and Kemmerich's peptone may be recommended, also somatose. There is no need of artificial preparations containing fat, except cod-liver oil and lipamin. The carbohydrate food preparations are very valuable: such as prepared oatmeal and gruels, malt extracts, bio-malt, Mellin's food, hygiama, guajakose, bioctin, and Riedel's levithin. v. Noorden has lately recommended riba, a fish albumen preparation, which can also be obtained combined with malt as riba-malt; our patients would take the latter, but soon refused the first on account of its fishy taste and smell, which are difficult to disguise. Before prescribing any preparation of this kind it is as well to inquire into price.

On the question of the use of alcohol we follow the middle path, and hold it to be not necessary for the consumptive, but also not harmful; a general prohibition is not justified. There is no compelling reason to make a tubercular patient a total abstainer. A glass of beer, or a glass of light table wine, should be allowed at the principal meals to those who eat better with it, for such small quantities of dilute alcohol certainly do no harm; they are rather favourable, as they increase the secretion of digestive juices. Even Forst recognizes the sense of well-being induced by alcohol in certain forms of weakness, and also utilizes its narcotic properties for inducing euthanasia; we wish to draw the attention of the strongly temperate physicians to this, when they stigmatize the supply of alcohol to feverish and hopeless phthisical patients as dram poisoning. On the other hand

alcohol must not be ordered as a tonic either with the meals or between them. Tubercular children and young people must not have alcohol in any form, even if it seems indicated. Great stress must be laid on the dangers of alcoholic excess.

According to what has been said a good plain fare is sufficient for tubercular patients, one meat course being enough at the mid-day meal. If patients desire and are accustomed to more it may be allowed; nevertheless we should remember that there is no advantage in a long menu, in which certain dishes are liable to recur with wearying frequency. Certainly more variety can be obtained by limiting the number of courses, which should be tastefully and appetizingly prepared and served; but tastiness must not be sought by excess of spices; piquant dishes difficult to digest must be limited in number or entirely avoided.

Careful mastication of the food is important. The patient must be allowed time to eat, so that he does not bolt his food. A defective set of teeth must be repaired and supplemented; till that is done the meals must be reduced. A fixed routine in the way of life and regular meal times are to be strictly adhered to. For it is just the habit of regularity in taking food that produces in most patients a feeling of hunger. "To give way at all hours to the whims and weaknesses of the stomach is bad" (Dettweiler). The meals must be separated from each other by two or three hours, for the stomach requires that time for its work.

The weight should be taken once a week, at the same hour, and in the same clothes. The normal weight, apart from slight variations due to sex, age, and calling, in adults should be as many kilograms as there are centimetres in the proportional height above a metre.

The proportional height is twice the distance from the crown of the head to the middle of the symphysis pubis. If this distance is 80 cm., for example, the proportional height is 170 cm., and the normal body weight should be 70 kilos.

The following arrangement of meals, in accord with the previous remarks, should be followed:—

(1) Breakfast at 7.30 to 8 a.m. Weak coffee, tea, or cocoa, with plenty of milk (half-pint), or porridge, white bread and butter (in badly nourished cases an egg, in cases of constipation brown bread, honey, or jam).

(2) Luncheon at 10 a.m. Half to three-quarters pint milk, cocoa, or thick soup, with dry or buttered bread, or an egg.

(3) Mid-day dinner at 1 p.m. Soup, meat course, potatoes and other vegetables, stewed fruit, or salad, a milk pudding (if more is required a fish course or a second meat course may be added). With this a glass of beer or wine or mineral water.

(4) Tea at 4 p.m. Tea, coffee, or cocoa with plenty of milk (half to three-quarters pint), with bread and butter and cake.

(5) Supper at 7 p.m. Soup, hot or cold meat or eggs, bread and butter and cheese; with a glass of beer or wine, or weak tea or mineral water (if more is demanded both hot and cold meat may be given, or another course may be added).

(6) Late supper at 9 p.m. Half-pint of milk, cocoa, or thick soup.

II. The Specific Treatment.

The specific treatment includes the means of producing both active and passive immunity. While the first method incites the organism itself to prepare actively the specific protective bodies, in the second method the protective materials are formed in other organisms, and are supplied as serums ready made to the tubercular patient, who therefore has nothing to build up for himself.

Active Immunization.

The tuberculins are used to produce active immunization. In Germany the most important and the most carefully studied and tried tuberculin preparations are the three of Robert Koch: the old tuberculin, the new tuberculin T.R., and the new bacillary emulsion-tuberculin B.E. Of these preparations the new tuberculin T.R. is hardly used to-day owing to its high price and slight durability; also it is by no means indispensable. By the side of the old tuberculin we have, what is according to Koch the still more completely albumose-free preparation, tuberculin A.E.: it is free from albumens, peptones, and meat extractive bodies, which the old tuberculin contains on account of the gelatine-broth, as it is prepared from cultures grown on an albumose-free fluid medium (asparagin). Also Koch's bacillary emulsion, in our opinion the best and most effective of all hitherto known tuberculins, has been rendered milder by the addition of a very valuable tuberculosis serum, the new preparation being the sensitized bacillary emulsion (S.B.E.), the tuberculosis sero-vaccine of Hôchst. Besides these, there are Denis's tuberculin, Landmann's tuberculin, Klebs's tuberculin, Béranek's tuberculin, Carl Spengler's bovine (perbucht) tuberculin, tuberculinum purum of Gabelowitsch, the iron tuberculin, and tuberculins prepared after Koch's method from tubercle bacilli of birds and fish.

Passive Immunization.

For the production of passive immunization there are Maragliano's serum, Figari's hæmo-antitoxin, Marmorek's antitubercular serum, and various antistreptococcic serums. The preparations for passive immunization have hitherto done so little in the treat-

ment of pulmonary tuberculosis that their value is more than doubtful. In any case they come so extraordinarily far behind the active immunizing tuberculins in effect and importance, that we may pass over them here without detriment to the value of this chapter. We would refer our readers to our book on "Tuberculin in Diagnosis and Treatment," which gives a detailed account of all these preparations.

The "passive-active" treatment of tuberculosis by means of Carl Spengler's immunizing body (I.K.) may be also passed over, since we have shown by extensive clinical tests that I.K. is useless for the treatment of human tuberculosis. Numerous other authors have obtained the same negative result. For this reason the latest attempts of Fran Fuchs-Wolfring to bring I.K. to the fore will never be successful.

**Tuberculin
Treatment.**

The tuberculin treatment attacks directly both the tubercular toxin and the tubercular foci in the lungs; and it is in fact these two points which require treatment. Whilst the hygienic and dietetic treatment aims only at increasing the natural resistance of the affected organism, the tuberculin treatment develops over and above this, by means of the production of artificial immunizing substances, an elective action on the morbid tissue, and produces results which are beyond the capacities of the hygienic and dietetic treatment alone.

The tuberculin treatment has not been irrationally added of recent years to the natural methods of healing; the substance introduced into the system is not antagonistic to the organism, but stimulates it to produce reactive products (antibodies), which it is not able of itself to form in sufficient quantities. By stimulating the vital functions to the formation of antibodies the tuberculin treatment imitates the natural process of self-healing, which it in fact reinforces. Thus the tuberculin treatment is in no way in opposition to the usual constitutional treatment. The general treatment of the patient must rather be necessarily joined with the tuberculin treatment, the latter being of the greatest service when full advantage of the hygienic and dietetic régime under medical supervision can be taken at the same time.

We therefore consider this combination of the two treatments to be at present the most efficient means of combating active pulmonary tuberculosis.

When the combination of both methods of treatment is not possible, tuberculin by itself must be employed, wherever it can be done. More will certainly be achieved with it than with any other method of treatment used by itself.

There is no need to enter into the details of the first tuberculin era, with its vague and incorrect methods of employing the remedy. We need only condemn the idea of producing by means of tuberculin "a generalization of the tuberculosis with mobilization of the bacilli," in case that still lingers anywhere.

Let us turn to the tuberculin therapy of to-day, and the present conception of it. It is peculiarly a gentle, gradual method, which begins with quite small doses of tuberculin and increases them only by very small amounts in the course of the treatment, so that strong reactions are avoided.

The method of avoiding reactions, as far as possible, serves for all forms of disease, and for all the tuberculins. It has great advantages over the original method of procedure. It is founded on the principle of *vil nocere* in the widest sense; it allows of reactions being entirely avoided, and yet of large doses being reached; it makes the tuberculin treatment practicable in the worst forms of tuberculosis; it does not prevent any other approved method of cure being carried out at the same time; and it may be carried out as an ambulant treatment without hindering the patient performing his occupation.

The two principal specific results of tuberculin are to raise the powers of resistance of the organism to the toxin, and to increase the flow of blood through the area of disease.

By becoming gradually accustomed to the tubercular toxin, and ultimately tolerant of it, the system is enabled to neutralize the effects of the bacillary poisons absorbed from the foci of disease, of which general symptoms such as headache, chest pains, loss of appetite, palpitation, faintness, disturbed sleep, nervous irritability, loss of appetite, fever or night sweats are common examples.

The second factor is the local hyperæmia, whose therapeutic value is familiar to us in the method associated with the name of Bier. On the one hand it leads to absorption of the inflammatory products round the tubercular foci, and, on the other, it favours a process of demarcation, with softening and expulsion of the irretrievably affected parts.

The lung is the one tissue of the body which is capable of undergoing cicatricial contraction with obliteration of the area of disease, even after extensive necrotic processes, while retaining its function as an organ. Moreover, in tuberculosis of the lungs there is not much danger of the breaking-down tubercular masses causing fresh damage, for the lung has the power in the greatest degree of getting rid of the products of destruction by means of the natural passages, and of the ordinary method of expulsion.

Outline of Tuberculin Treatment.

The principles of the modern tuberculin treatment are shortly as follows: As the sensitiveness to tuberculin is different in individual cases, the treatment must be strictly adapted to the individual. Therefore no universal scheme can be given, only a general outline founded on the fact that severe reactions can be avoided by small doses. To this end we must be guided first of all by the body temperature, the regular and exact measurement of which throughout the whole treatment is absolutely necessary. Slight reactions may take place, however, without fever, and may be recognized by such general symptoms as headache, faintness, &c. For this reason all such conditions should be carefully inquired for.

The observations of the body-weight and of the pulse give further indications whether we are proceeding rightly with the dose. They inform us whether we may carefully proceed to increase the dose, or must continue longer with the same. In some cases a distinct rise of temperature compels us to postpone the injection for a few days, until the fever has completely subsided, and then to repeat the same dose, or in the case of a very severe reaction to begin again with a smaller dose.

There are thus a whole row of signposts, which should be sufficient to keep us in the right path during tuberculin treatment. It need not be emphasized that a careful and regular examination of the lung must form part of the course; and that the physical signs are to be regularly noted and compared.

But in spite of all care and experience, the demand that all fever reactions, even the slightest, should be avoided, cannot be always fulfilled. This, however, is not immediately attended with injury to the patient; on the contrary, a small push forward, a so-called *relax mechanizatoria*, is often given thereby with good effect, especially in indolent, torpid cases. There only remains to be considered the possibility of the patient being overloaded with toxin, which shows itself as super-sensitiveness to the poison. In such cases of excessive toxæmia and super-sensitiveness the repetition of the same, or even of a smaller, dose of tuberculin, is apt to cause a greater febrile reaction than the original dose. According to results obtained by the use of Wright's opsonic index it is probable that these cases are in the negative phase, during which the anti-bacterial power of the blood is diminished. Here it is best to introduce a break of eight or even fourteen days, and to recommence with a considerably smaller dose, which must be very slowly raised with redoubled care.

We therefore advise the beginner to lay special stress upon

the avoidance of reactions in the tuberculin treatment, but not to be impatient and give up the treatment at once if super-sensitiveness should occur.

As sites of injection the skin between the shoulder-blades or in the loin may be chosen, the right and left sides being used alternately. We recommend the morning hours as the time for injection, not the evening. The intervals between the doses vary, apart from the effect of the last injection, with the dose; with small doses injections may be given every second day, with larger doses twice a week, and with the largest every eight to fourteen days. Injections every day are too often. Other methods of giving tuberculin, besides subcutaneous injection, are both more troublesome and of less value.

The gradual increase of the dose must in no way be precipitated in order to attain the highest possible dose or to be finished with the cure at a certain time.

Those doses of tuberculin are always of most use to the patient that he can just bear without reaction, and it is not nearly so important to climb up to a certain dose of tuberculin as to employ only those doses that the patient can deal with.

Upon this depend the questions as to how long the tuberculin treatment should last, and with what final dose it should be brought to an end. Definite instructions cannot be given on these points, as the most varied circumstances must be reckoned with. It may, however, be generally stated that the patient, as soon as he notices the beneficial effect of tuberculin, will wish to continue the treatment till he is cured. A normal standard of an absolute maximum dose can be ignored, but our efforts must still be directed to reaching the greatest dose that the patient can deal with.

In cases where healing is not attained by tuberculin it is advisable to give several repeated courses, on the method proposed by Petruschky.

Indications. What cases of tuberculosis are suitable for treatment with tuberculin? The question

may be answered in different ways, according to the individuality of the cases, according to the experience of the doctor, and according to the external circumstances. Complications affecting other organs, and the state of the constitution, also play a part. This much, however, we may state as a guide to practice, that every uncomplicated, afebrile case of pulmonary tuberculosis of the first and second grades can be treated by means of the gradual, reactionless method. Also that the so-called cachectic consumptives, who, in spite of a bad state of general health and

a delicate appearance, often have only slight physical signs in the lungs, respond very well to tuberculin treatment.

Contra-Indications. Tuberculin treatment is chiefly contra-indicated in severe forms of tuberculosis, with high fever and mixed infection, in patients, often of a ruddy and plump appearance, who have diffuse mischief in both lungs, in very weak individuals, in hæmophiliacs and patients with very frequent severe hæmorrhages, in severe organic heart disease, and in marked cases of diabetes, cirrhosis of the liver, nephritis, neurasthenia and epilepsy. Further, those patients are less favourable who are prone to inflammation and subsequent caseation, and those febrile cases following broncho-pneumonia, measles or influenza, in which the disease slowly spreads over a whole lobe of the lung without fever. In estimating contra-indications, the beginner should be more exact and comprehensive than he who has had considerable practical experience with tuberculin.

The foregoing are generalities characteristic of treatment with all the tuberculins.

General Remarks on Tuberculin. The consideration of the individual specific preparations, their peculiarities, their method of manufacture and their exact mode of employment would not be in place here. A common agreement of the whole medical profession on the subject of specific treatment seems to us to be both possible and of the most pressing necessity; for this we consider that a fundamental study of the theory and practice of the specific tuberculin treatment is absolutely required. We cannot therefore undertake here to go into details, or to give a sketch of the employment of any special preparation. Whoever takes up tuberculin treatment must first master the general details of the use of this valuable remedy, and must have the desire and the ability to make himself familiar with the various irregularities which may occur. Whoever is not prepared for this useful study would not be benefited by a mere sketch of the details of the method, and would be rather encouraged in his attitude of refusal than drawn in as a fellow-worker.

From these considerations, for a theoretical study of the question we refer our readers to certain chapters of our book on "Tuberculin in Diagnosis and Treatment," which contains what is absolutely necessary, leaving it open, of course, to anyone to obtain information elsewhere. We only warn most emphatically against starting injections on the instructions of a prospectus in favour of some special preparation. Accounts of the tuberculin

treatment, according to Dr. N. or Dr. Y., are even dangerous on account of their unintentional bias. Without fundamental knowledge of the preparation and its peculiarities the doctor who uses it in a single case will frequently do harm instead of good. This holds good of all therapeutic systems, but specially so for the tuberculin, on account of their specific varying actions. The melancholy experience of the first introduction of tuberculin is not a warning against the use of tuberculin, but an argument in favour of its proper and selective employment. What formerly was ignorance would to-day be culpable carelessness, culpable because it can be avoided.

The practical study of the specific treatment is nowadays possible in sanatoriums, dispensaries and most hospitals. In Germany post-graduate courses for the study of the use of tuberculin have been organised. By combining a theoretical study of the action of tuberculin with practical experience in the method of its use, we shall arrive at that safety which makes the specific treatment of pulmonary tuberculosis practicable in its widest range and full of possibilities.

III. Surgical Treatment.

The surgical treatment of pulmonary tuberculosis is chiefly adapted for quite early or for far-advanced cases; also for moderately severe cases in the commencing stages.

The direct attack on the affected part of the lung has not afforded any good results. Neither attempts to remove apparently localized nodules in the lung nor the opening up of tubercular cavities have been satisfactory, and both operations are very dangerous.

Of the operations which do not attack the diseased lung itself, both division of the first rib cartilage and the paravertebral resection of the first rib are intended for cases of early tuberculosis.

Chondrotomy.

The surgical treatment of early tuberculosis is founded on the work of Freund and his pupils, and of Hart, on the mechanical disabilities of the apex of the lung in phthisical cases. According to these authors an abnormal shortness and a separate ossification of the first rib cartilage lead to stenosis of the upper aperture of the thorax, and this creates, on account of deficient entry of air into the apex of the lung, an opportunity for the lodgment of tubercle bacilli; and by weakening also the natural resistance of the lung tissue favours the development and spread of the disease.

Chondrotomy of the first rib cartilage is therefore proposed as a treatment designed to remove the cause by bringing about a widening and mobilization of the upper thoracic aperture.

The indications for the operation were discussed in detail at the Twenty-ninth German Surgical Congress (1910). It was agreed that neither the paralytic thorax nor the senile thorax were suitable for this operative procedure; and Freund's type of chest only when the tuberculosis of the apex has not advanced further than the second rib. Apart from this the indications depend on the form of disease. Bronchitis and asthma are not contra-indications. Local disturbances of the circulation must be, as far as possible, relieved before the operation by medical treatment. In suitable cases division of the first rib cartilage should not be delayed too long; while on the other hand it should not be undertaken if the same results can still be achieved by suitable exercises and gymnastics. It is only justified after exact clinical observation has been carried out for a long time; it is not to be employed as a prophylactic operation.

The following arguments may be raised against chondrotomy. First the diagnosis of this stenosis presents great difficulties; and it is not certain how often, and in what degree, pulmonary tuberculosis arises in consequence of stenosis of the upper thoracic aperture. By means of careful pathological and anatomical examinations it has been shown that in many cases the change in the first rib cartilage may occur secondarily, and it must not unconditionally be made responsible for the onset of tuberculosis. Secondly, it is not proved that chondrotomy induces improved respiratory mobility and healing in the portions of the lung damaged by stenosis; on the contrary, Tendeloo fears that the increased movement might have an injurious effect on the inflamed parts of the lung, like massage on tubercular tissue. Chondrotomy, too, only does away with the fixation of the first rib without increasing the size of the aperture of the thorax; and the mobility of the first rib has no such very important influence on apical tuberculosis as Freund assumes. Thirdly, chondrotomy is not free from danger owing to the close proximity of large veins and the nerve plexus.

We are not now so powerless against apical tuberculosis as to require an operation, the results of which are at least doubtful, both theoretically and practically; and we feel obliged to deny the advantage of chondrotomy for apical tuberculosis as long as the indications and results of the operation rest on no surer basis than at present. There are, up to the present, only twelve cases known of such operation.

Paravertebral Resection of the First Rib.

Bacmeister's animal experiments, consisting of an artificial narrowing of the upper thoracic aperture by wiring the costal cartilages, showed that the greatest pressure of the first rib on the lung occurred at the latero-posterior portion. Since the relationships of the first rib are quite analogous in the animal and human body, from these experiments has been derived the idea of dividing the narrowed first rib ring in its paravertebral part, where it exerts the greatest pressure. Sauerbruch and the Zurich surgical school consider that posterior paravertebral resection of the first rib is indicated in apical tuberculosis with Freund's narrowing of the first rib segment. But we must deny the utility of this operation also, as it, like chondrotomy, only aims at mobilizing the first rib segment. But to what extent its fixation is concerned in the production of pulmonary tuberculosis, and to what extent operative division of this ring favours healing, is doubtful. Hypotheses and analogies can furnish no indication for the operative treatment of lung tuberculosis in its early stages, which experience has shown may be cured by medical means alone.

Artificial Pneumothorax.

In severe, essentially unilateral cases of pulmonary tuberculosis surgical treatment to induce collapse of the lung by means of artificial pneumothorax may be indicated.

The formation of the pneumothorax may be brought about either by Forlanini's method of simple puncture, or by the method of Murphy and Brauer of cutting down on to the surface of the pleura. Nitrogen gas is introduced into the pleural cavity under the control of a pressure gauge, to the extent of at least half a litre at the first sitting. The danger of injury to the pulmonary pleura or of producing a fatal air embolism is to be avoided. According to our experience this can be better done by the method of incision than by Forlanini's puncture. The later introductions of gas, the necessary frequency of which is to be decided with the aid of the Röntgen rays, can be done with the simple puncture needle; at first at intervals of eight, ten to fourteen days, later of three, four to five weeks. The duration of time during which the lung must be kept under the pressure of the pneumothorax depends on the form of disease; on the average it is about one to two years.

The collapse treatment of the lung by means of a pneumothorax depends on the tendency to heal by cicatricial contraction. It aims at producing a compression and immobilization of the lung, and by inducing stasis in the blood-vessels and lymphatics of the collapsed lung to diminish the amount of toxic

absorption, to the benefit of the whole organism. The diminution of toxic absorption also acts locally by permitting an increased growth of connective tissue, with demarcation of the diseased areas. The collapse and inactivity of the lung also lessen the amount of secretion produced in the diseased areas and the aspiration of this secretion into other healthy parts. Lastly, full play is given to the contractile tendency of a tubercular lung, unhindered by the restraining influences of the chest wall.

In fact, the anatomical changes which come about under the influence of an artificial pneumothorax consist of enormous connective tissue formation and contraction, even to obliteration of the bronchioles and alveoli, and further in dilatation of the lymphatic spaces with deposition of carbon particles and invasion of the epithelium by connective tissue, without the formation of fresh centres of disease. This explains the favourable influence on the phthisical patient. The diminution or cessation of toxic absorption is followed by improvement in the general state of health, shown by fall of temperature, increase in the appetite and state of nutrition and cessation of the night sweats; while the progressive sclerosis of the lung leads to decrease and disappearance of the sputum and bacilli.

Only a few general directions can be given as to the indications for the operation, which will be frequently helpful in forming a decision, but which occasionally lead one astray. The establishment of an artificial pneumothorax is necessary, that is to say, is to be strongly advised, if the tubercular mischief is unilateral, but so severe and widely spread in the affected lung that, according to clinical experience, healing without the operation is improbable or impossible. Progressive, moderately severe cases, which are advancing on one side in spite of all treatment, should be subjected to the compression before they reach the third stage. Forlanini lays down the rule, which Wellmann rightly emphasizes, that it is not the extent, but rather the steady progress, of the disease, which gives the indication for the operation, and all the more so if there are still considerable healthy areas in the lung to be compressed. There are cases, examples of which we have seen lately in the Pathological Institute at Göttingen, in which, in spite of most severe disease on one side, the other is quite sound, even microscopically.

Artificial pneumothorax is also justified and permissible if, with severe disease on one side, there is no active or extensive mischief on the other; that is if the other is practically sound, apart from slight and inactive changes. To-day great stress need not be laid on the one-sidedness of the disease, since Forlanini has reported cases in which he has attacked first one side and

then the other in stages, and has effected cure. Other authors operate on cases where one side is badly diseased, if not more than a third of the other is affected, without marked destructive changes. Disease of the upper lobe on the less affected side affords a better chance than even slight destructive disease of the lower lobe; in the latter case, i.e., severe disease of one lung with evidence of breaking down in the opposite lower lobe, the indications for the operation are more than doubtful.

Whether artificial pneumothorax is practicable depends on the pleura; absence of adhesions makes Brauer's operation simple; slight, new, or at least not too old, adhesions on the diseased side cause no difficulties that cannot be overcome; if their presence is ascertained by the Röntgen-ray examination they do not contra-indicate the attempt. On the other hand, dense pleural thickenings make every attempt hopeless, and extensive pleural adhesions prevent the formation of a sufficiently large pneumothorax. Holmgren has recently recommended, in cases of adhesions, as a preparatory measure, that sterile physiological salt solution at a temperature of 40° C. should be forced by an india-rubber syringe through a needle into the pleural cavity; after this the introduction of the nitrogen gas takes place without difficulty. Rüdiger, Klemperer and others warn emphatically against the forcible breaking down of adhesions. We also must point out that the preliminary intra-pleural injection of salt solution is not without danger, even if it is not also useless.

As strict contra-indications for the operation, apart from extensive adhesions on the side in question, we have (1) considerable destructive disease on the other side, and (2) severe complications in other organs, which does not include slight laryngeal disease, or non-tubercular diarrhoea.

It is necessary for success that a sufficiently large pneumothorax can be formed. The dangers are remote with proper technique. Bad results to the other lung can be avoided by proper selection of cases; injurious effects on the heart and respiration by proper regulation of the amount of gas introduced. If the patient becomes worse, or if undesirable complications supervene, the nitrogen gas can be drawn off. A serous pleural effusion not infrequently occurs, but it usually runs a short and mild course, and does not disturb the continuation of the pneumothorax treatment.

There have been numerous reports of favourable results, especially by Forlanini, Brauer, Saugmann, L. Spengler, V. Mairalt, and others.

L. Spengler reports the results of 1171 cases as: 45 per cent. very good, 42 per cent. good, 13 per cent. satisfactory, and only 15.5 per cent. unsatisfactory, and 7.5 per cent. deaths; and also gives the same results in fifteen cases nine months at least after the production of the pneumothorax, in whom none suffered fever, cough, nor emaciation, and who worked full capacity for work. Of these fifteen cases, twelve before the operation had an absolutely bad prognosis and three an unfavorable one. Of these patients five had ages between 31 and 35, five between 22 and 30, four between 31 and 35, and one of 43 years; in seven cases the pneumothorax was on the right side, in eight cases on the left; in nine cases a complete, and in six cases an absolutely almost complete, pneumothorax was obtained. As a complication in seven cases an effusion occurred, and in seven the pneumothorax remained almost dry, in one case a pre-existing effusion became gradually replaced by nitrogen. The time from the first filling to the last was in one case only 2 months, once 3, in six cases 2 years, in three cases more, and in four cases 13-24 months. The dry pneumothorax remained after the last filling from 24 months on one surface, those with effusion between 3 and 10 months. The pneumothorax came to an end in one case after 3 months, in six cases after 1-1½ years, in seven cases after 1½ years, and in one case after 4 years.

There is thus proof that lasting results may be obtained by means of artificial pneumothorax, even in desperate cases. In all cases the treatment makes great demands on the patience of the invalid and the doctor. It is also necessary that the patient should have the advantage of good social and hygienic conditions of life for some years, on account of the care that must be taken and the drawbacks that may be met. From our own experience we may summarize the present standing of the pneumothorax treatment by saying that it is only suitable for a comparatively small proportion of cases of pulmonary tuberculosis, and that the treatment is successful in only a certain percentage of those cases, and that of the successful cases there is again only a certain percentage of lasting results, as L. Spengler especially has noticed.

But in contrast with chondrotomy and paravertebral rib resection in initial cases, it may be emphatically asserted that the pneumothorax treatment must be considered for severe cases with bad prognosis, that is, for cases which are beyond cure by constitutional and specific treatment.

The pneumothorax treatment must be reserved for patients in institutions, and lies within the sphere of the physician, as the surgical technique is quite overshadowed by the medical judgment required in considering the indications.

**Extra-pleural
Thoraco-plasty.**

This procedure dates back to the publications of Quinke (1888) and Carl Spengler (1890). While Quinke claimed, that if the presence of a tendency to contraction can be proved in cases of destructive

changes in the lung, such tendency to contraction and healing would be favoured by mobilizing the chest wall; Carl Spengler has recommended "thoraco-plasty without opening the pleural cavity" in the treatment of "tubercular cavities with rigid walls." The aim of the operation is to put the chest wall into such a condition that the diseased lung becomes collapsed and motionless. Rib resection, with more or less extensive removal of bone, is therefore necessary to influence the mechanical conditions of the chest wall and the breathing capacity and circulation of the lungs. With these objects there are two procedures in use: (1) The diminution of the thorax by means of resection of ribs as practised by Wilms, and (2) Friedrich's thoraco-plastic pleuro-pneumolysis.

Wilms recommends, in cases of unilateral disease of the upper lobe and in unilateral cavity formation, the removal of pieces of ribs of 1 to 1½ in. long in the neighbourhood of the costal angle, and if this posterior resection is not sufficient the removal of the rib cartilages with bone forceps. There is thus produced a diminution in the size of the upper part of the thorax and compression of the tubercular apex, while the breathing in the other lung is unaffected. Marked external deformities are avoided, and the operation can be done painlessly under local anaesthesia. The chief necessity for the operation is that the tubercular mischief should not be recent, but of chronic fibroid or fibro-cavernous nature. The operation is contra-indicated if, besides the upper lobe, the lower lobe or other organs are affected. The results of cases of apical tuberculosis hitherto operated on have been surprisingly successful; increase of bodily strength and weight, fall of temperature, markedly rapid and steady decrease in the amount of sputum, diminution and cessation of the cough; in fact, all the recognized results of lung collapse, have been observed. In eight cases Wilms has up to now had no deaths.

From a therapeutic standpoint we consider that Wilms's operation is unnecessary for chronic indurative apical tuberculosis. If one proposes to operate on such forms of tuberculosis as are tending to heal it must be because one doubts the possibility of curing lung tuberculosis without an operation, which is not a justifiable position. On the other hand, the operation may be considered, on account of its simplicity and relative freedom from danger, for those cavities of the apex which, under suitable treatment, show no sign of contracting or drying up, and which are prevented from doing so by the state of the chest wall. Such cavities, however, seldom occur; if they do not

improve under suitable treatment they are apt to assume a quickly progressive character without fibrosis, and that, according to Wilms, is a contra-indication. We therefore think that the conditions for Wilms's operation are fulfilled in only extremely few cases. At the most it can only compete with the artificial pneumothorax in cases of concurrence of apical tuberculosis and pleural adhesions.

The much more extensive operation of total or partial excision of the ribs Friedrich considers indicated in cases of "fibro-cavernous" unilateral tuberculosis, of not very acute course, with or without fever, which, in spite of exhaustive general and climatic treatment, is still progressing unfavourably; so that the prospects of cure continually recede. There must, however, be a sufficient amount of strength, and the age must not be under 15 years nor over 45; as below the first age the operation necessitates too great interference with the growth of the bony framework, and above the second the tissues of the chest wall and the diseased lung no longer have the necessary power of contraction to produce a cure by this method. A tendency to contraction and adhesion of the pleural surfaces on the diseased side is a specially favourable indication. Less severe and older disease in the other lung does not contra-indicate the operation, as do recent infiltrations, and complications in the larynx, bowels, and bones. The existence of bacilli is a matter of indifference. It must be decided for each case by a careful estimation of the patient's power of resistance and capacity of his heart, the form of disease in the lung being also considered, whether the total removal of bone from the chest wall or a partial resection of the ribs is to be undertaken, and whether the operation is to be completed in one or more sittings. It is important to operate as quickly as possible; the costal pleura must always be preserved, and also the pericostum, which ensures a greater firmness of the chest wall later. Too little bone should never be removed; neither should two or three ribs be resected every year, as then the lung does not contract sufficiently, nor does the patient survive to the final operation. The effects of the operation are abatement of the fever and sputum, and improvement in the general condition and body-weight, and a permanent contraction of the lung and obliteration of the cavities. The dangers of the operation are great (syncope, aspiration of septic material into the sound lung, &c.). Friedrich, in spite of his great experience of the operation and its after-treatment, admits eight deaths in twenty-nine cases, and of these six had tubercular metastases in other parts of the body; on the other hand he obtained complete capacity for work

in six cases. That is certainly a success considering the unfavourable state of the cases operated on; but the results altogether are far from satisfactory. It is certain that Friedrich's thoraco-plastic operation may produce severe deformity of the chest, even on patients above 15 years, and that there are frequent troublesome after-effects on the heart. It must be performed only by very experienced surgeons on carefully selected cases, in which the artificial pneumothorax is impossible on account of extensive adhesions.

IV. Drug Treatment.

The number of drugs recommended for pulmonary tuberculosis reaches to hundreds, and new preparations are constantly being added on account of the activity which exists in this branch of therapeutics. It is exactly this excessive number of remedies, and the rapidity with which each appears and disappears, which indicates their very slight efficacy, and calls for caution on the part of the doctor.

It is not possible to kill the tubercle bacilli by any medicament taken internally, or even to weaken them. For those substances which kill or weaken the bacilli are, if sufficiently concentrated, also poisonous for the tissue cells, and would injure the whole organism. An antitoxic effect, that is a power of neutralizing the toxins of the tubercle bacilli, has not been demonstrated for any chemical substance.

On the other hand it may be possible for a drug to raise directly the resistance of the still healthy lung parenchyma against the tubercular virus, perhaps by producing a leucocytosis. But it is much more likely that those drugs which have a favourable effect act by improving the general condition of the patient, raising his appetite and state of nutrition, and thereby producing indirectly an increased resistance of the lung tissues. Such possibilities and probabilities make it impossible to reject on general grounds the treatment of pulmonary tuberculosis by drugs; in many of the complications of the disease, also, they can hardly be dispensed with. On the other hand we must always ask ourselves whether the drug in the customary doses is absolutely harmless, and whether the advantages of its use counterbalance the disadvantages. If we are guided by these considerations we shall make but restricted use of the less tried remedies.

Creosote and Guaiacol Preparations.

Creosote has been much prescribed from the year 1850 to the present day. Whilst the earlier mineral preparation caused harmful effects and even poisoning, the vegetable variety has proved a gastric and intestinal disinfectant,

very effective for that purpose in the initial stage; it is not uncommon also to see the sputum diminish with creosote.

It may be given in the form of drops (creosote 1 part, tincture of gentian 2 parts, 8 to 20 drops in water three times a day) or mixed with wine according to Penzoldt's formula (creosote 5i, tr. gent. ʒi, spr. vin. rect. ʒi, sherry wine to ʒviij; ʒss t.d.s. in water). The most pleasant prescription is that of 1 to 1½ minims of creosote with cod liver oil or other oil in a gelatine capsule. Creosote pills are of no use, as they are mostly passed unchanged in the stools. The creosote preparations must never be taken before breakfast, or on an empty stomach. They are contra-indicated in gastric disturbance, hæmoptysis, and kidney disease. The urine must be examined from time to time for albumin. Should irritation of the kidneys, disturbance of appetite or digestion, or even a strong aversion from the unpleasant taste and smell ensue, then creosote must be abandoned.

Guaiacol as a substitute will not as a rule be better tolerated, for its principal ingredient is creosote, and it does not taste or smell much better. From a considerable number of trials of the painting of pure guaiacol on the skin to reduce fever we have seen no good results. The subcutaneous, rectal, and intrapulmonary administration of guaiacol seems to have been rightly abandoned. The compounds of creosote and guaiacol with carbonic acid are much easier to take. Duotal (carbonate of guaiacol) is ordered in doses of 3 to 6 gr. t.d.s. in cachets; creosotal (carbonate of creosote) in doses of 5 to 30 drops t.d.s. in milk or wine half an hour after food. Other guaiacol preparations are thioeol (5 to 15 gr. t.d.s.) and for children 10 per cent. solution of thioeol in orange syrup, and sinolin (1 to 3 teaspoonfuls a day). Also eoseol (creosote valerianate) and geosote (guaiacol valerianate) are recommended; as are pulmoform and pneumin, which are produced by the action of formaldehyde on guaiacol and creosote. The latter has not, according to the exact observations of Hall, very good effects on intestinal and pulmonary symptoms. A more favourable opinion can be passed on guaiacose, a solution of 8 per cent. guaiacol sulphate of calcium and fluid somatose, on account of its beneficial effect on the appetite, night sweats, sleep, and cough.

**Balsam of Peru,
Cinnamic Acid,
Hetol.**

According to Landerer, balsam of Peru produces round tubercular foci, a reactive inflammation leading to healing. Later Landerer extended the use of balsam of Peru from surgical to pulmonary cases. The molecules of the emulsion of yolk of egg and balsam of Peru were supposed to be carried by the blood-stream to the tubercular foci and not

there. Still later Landerer recommended in the place of the Peru balsam emulsion which is difficult to produce, cinnamic acid in the form of its sodium salt, hetol, for intravenous injection in dilute solution. Although Landerer does not claim that hetol is a specific against tuberculosis, yet he considers the action of cinnamic acid on the tubercular processes as unique in its way, resembling in its chemiotactic properties the antitoxins and antibodies. Animal experiments show that under the leucocytosis induced by hetol tubercular nodules in the lung become shut off and encapsulated. Unfortunately the results of intravenous injections of hetol on human patients neither corresponded with those of animal experiments, nor confirmed the very good results which Landerer himself obtained. Our own experience has been that long continued hetol injections have neither prevented the recrudescence or the advance of the disease, nor the formation of new foci, in spite of supplementary treatment in an institution.

According to Landerer's instructions a 1 per cent., and later a 5 per cent., aqueous solution of hetol should be used. Before use it must be sterilized in a water bath and then injected intravenously at the bend of the elbow. The treatment is commenced with 1 c.c. of 1 per cent. sol. (= 1 mg.), increasing each second day by 1-20 to 1-10 c.c.; after a dose of 10 mg. is reached the 5 per cent. sol. is used, of which 1 c.c. = 5 mg. One should not go beyond 15 to 20 mg. If a hæmorrhage occurs the injections should be stopped for at least fourteen days, and should then be very slowly increased up to a maximum of 5 mg. For further information we refer the reader to Landerer's article. The advocates of the hetol injections are continually pressing the claims of the treatment, apparently without result. Blas recommends the combination of tuberculin and hetol, the latter provides the necessary leucocytes for the action of tuberculin. "When combined with hetol, Koch's lymph has become the efficacious and harmless agent in the contest against tuberculosis that it deserves to be" (Blas).

Arsenic Preparations.

Arsenic was introduced into phthisical therapeutics by Buchner for the reason that it increases the power of resistance of the lung tissues. The enthusiastic statement of Kemper, that the effects of arsenious acid in improving the general constitution equalled that obtained by the most approved and expensive methods of cure, was not endorsed by the German Medical Congress (1884).

Lately Burow, on the ground of experimental researches, has stated that guaiacol arsenate is "a real and active anti-tubercular

remedy," in which the arsenic acts as a specific against the tubercle bacilli, while the guaracol is a specific against the toxic products of breaking down living matter, the tox-albumins. Neither statement is correct according to Nürnberger's work in the Erlanger Pathological Institute; guaracol and arsenic do not prevent the growth of bacilli either separately or combined; moreover, both substances have not the slightest effect on tubercle inoculations on rabbits and guinea-pigs.

If the organic arsenic compounds are used to a certain extent in sanatoriums it is to stimulate the blood-forming organs. We prefer the subcutaneous injection of sterilized sodium cacodylate (5 c.c. then 1 c.c. of a 10 per cent. aqueous solution two to three times a week), or arsacetin (1½ to 3 gr. in watery solution every two or three days), which is just as effective, and three or four times less toxic than ioxyl, or the soluble iron-arsenate. Natural arsenical water, as Dürkheimer, is very efficacious and suitable. Also *uschlogen*, which contains arsenic, may be used. In over 200 cases we have seen no advantage in the arsenical bacillary emulsion tuberculin, prepared from human tubercle bacilli grown on a medium containing arsenic, over the ordinary bacillary emulsion tuberculin of Koch.

Iodine Preparations.

Iodine is of value when syphilitic or parasymphilitic manifestations are associated with tuberculosis. It generally exercises a favourable effect on the expectoration, for which purpose according to Köhler iodo-glydine (Klopfer) is the best. Not uncommonly, however, potassium and sodium iodide act most unfavourably on the gastric functions of tubercular patients; and iodism frequently interrupts the treatment. Iodoform, though useful in surgical tuberculosis, has no good effect in pulmonary cases, either when given internally, in pill form, or when injected into the parenchyma of the lungs. We have seen no good from iodipin either internally, subcutaneously, or intramuscularly; once in spite of strict aseptic precautions an abscess formed in the gluteal region. We have no personal experience of the iodipin-menthol injections (menthol 10, eucalyptol 20, 25 per cent. iodipin 30 parts; 1 c.c. daily).

Recently the radioactive menthol iodide has been energetically advertised under the name of dioradin (Dr. A. von Szent-deffy). Bernheim, of Paris, states that he has only had ten failures in 173 cases of phthisis of the most varied nature treated with dioradin injections. The dioradin treatment is given in a series of 40 injections; in initial cases 1 to 2 series are sufficient to stop the spread of the disease, in severe cases 4 to 6 series are neces-

sary, that is from 40 to 240 injections, and as a packet for six injections costs nine shillings, initial cases require £3 to £4 worth, and severe cases £12 to £18 worth of dioradin. The assertions that the combination of iodine, menthol, and radium forms "the most potent antitubercular reagent imaginable," and that "no other therapeutic means up till now has had such striking results," are to be received with caution. The *Lancet* describes the experimental results of Szendeffy and Bernheim as inexact, the clinical data as incomplete, and the chemical constitution of the remedy as unstable. We should like to underline the last objection in reference to the components producing the radium emanation, which, moreover, are slight in dioradin.

Other Drugs. Ichthyol in drops, pills, capsules, and mixtures has been recommended, but has no

advantage over the creosote and guaiacol preparations.

In administering camphor we prefer the subcutaneous use of oil of camphor* in cases free from fever, and have seen a favourable, but not constant, effect on the heart, pulse, and respiration with daily injections of 1 c.c. (1 lb. is of no service as a febrifuge).

Mercury (hydrarg. thymolo-acetate) has no good effect unless syphilis is present with the tuberculosis. In such cases we have been able to bring about an improvement in the lung condition by means of a prudent inunction treatment, but often it was not lasting.

The carbonic acid treatment of Weber and the cantharides treatment of Lachnisch need not be dragged from their well-deserved oblivion.

The chemical treatment of tuberculosis by means of methylene-blue, particularly iodine methylene-blue and certain copper compounds, introduced by Finkler, is still in the experimental stage.

V. Inhalation Treatment.

We are justified in approaching the inhalation treatment very sceptically. Without going into the practice of inhalation from the times of Hippocrates downwards, we must allow the possibility of drugs in the form of powder, fluid, or steam being drawn into the respiratory organs, and that those in the form of gas can penetrate even into the deeper parts of the lung. But we know as yet no medicinal substances which can be carried in such quantity, and such concentration, to the tubercular deposits, as to be able to heal or even arrest them. The cells lining the

* Camphor 1, olive oil 9 parts.

air passages would be first injured, and a general toxæmia set up. Tubercular deposits are either cut off from the general air currents by the inflammatory swelling of the surrounding structures, or if tubercular cavities are open they are unaffected by inhalations because they have lost their power of absorption. Also we cannot limit the action of inhaled drugs to the diseased areas, but they must also come in contact with the healthy mucous membrane. Owing to the sensitiveness of the lining epithelium inhalation of only quite dilute and feebly acting substances is permissible; and even these may have an irritating instead of a sedative effect, and produce much coughing. Inhalation therefore can hardly be reckoned as a method of cure of pulmonary tuberculosis. Only in rare cases in which the disease is localized in the larger bronchi has it a certain justification as an adjuvant treatment.

Inhalation of Powders.

On the ground that pulmonary tuberculosis is comparatively rare amongst the men working in chalk and gypsum works, in spite of an excessive inhalation of dust, inhalation of finely powdered chalk has been considered to have an immunizing effect and has been recommended as a form of treatment. Several years ago we made attempts in this direction, making the patients bear chalk bags and inhale the dust. The results were absolutely discouraging; in nearly every case an increase in the cough and expectoration led to the cessation of the treatment.

Inhalation of Fluids.

Apparatus of the most varied kinds has been constructed for the inhalation of fluids, with the intention of spraying cold medicated solutions by means of compressed air, or warm fluids by means of steam. For producing inhalations on a large scale there are the systems of Wassmuth, Reif, Bulling, Mach, Clar, and others; on a smaller scale for hospitals and sanatoriums the ideal steam spray of Wassmuth may be used. Without entering into a criticism of individual systems, we may say that the medicament must be scattered in the finest spray. In spite of this it is doubtful if it reaches the alveoli. The likelihood is less with nasal than mouth breathing. It is thought that the detention of tubercular cases in private and public inhalation rooms leads to diminution of the irritating cough and loosening of the secretion.

A cold spray of chloride of iron solution is recommended in cases of hæmoptysis. We must issue a most emphatic warning against all kinds of inhalation in cases of hæmorrhage. For those phthisical patients who are tormented by obstinate rough sputum and continual cough, or who are burdened with much

catarrhal secretion from the upper air passages, a warm inhalation may be considered. As a simple apparatus for the use of individual patients we may mention Siegel's inhaler, and also Jalir's and Heyer's apparatus, and Belling's thermo-variator. We strongly advise that the price should be ascertained before ordering any apparatus; in any case Siegel's is the cheapest.

For the purpose of loosening phlegm, salt solution or Ems water may be used as an inhalation for ten to twenty minutes two or three times a day.

The addition of antiseptics such as carbolic acid, sublimate, creosote, guaiacol, boracic acid, formalin, &c., is often recommended, but must in all circumstances be avoided. Solutions of morphia and cocaine are also best kept out of the inhalations. On the other hand volatile oils such as menthol or eucalyptus may be used in cases of decomposition of sputum in cavities, as may also turpentine and pine oil for diminishing and deodorizing the secretion.

Inhalation of Vapours.

The volatile oils penetrate still better into the lungs as vapours. For this purpose the medicament is placed on a mask, such as Curschmann's or Hartmann's, and inhaled, or is vaporized in a bowl over a spirit lamp and inhaled through a funnel. Of the forms of apparatus constructed for the purpose we may mention Simon's inhalation flask, and Schreiber's, Snger's, Heryng's, and Rosenberg's modifications. F. Kraus recommends Spiess's vaporizing apparatus, which by means of a stream of carbonic acid gas delivers all the usual medicaments in such a fine spray that they are sure to reach the bronchial mucous membrane. We prefer Snger's apparatus and corffin (Bayer-Elberfeld) as the medicament, and obtain with it immediate relief in acute or sub-acute laryngitis and trachitis, that is to say, alleviation of those attacks of coughing so prejudicial to the tubercular lungs.

Inhalations of ligno-sulphite, a combination of volatile oils with sulphuric acid, have been recommended. We have noticed no favourable results, and enjoin caution, as the ligno-sulphite vapours are not without action on the healthy bronchial mucous membrane.

Gaseous Inhalations.

Inhalation of gases has been recommended at various times; but for the last few years has been given up. Nitrogen, carbonic acid gas, sulphuretted hydrogen, prussic acid, chlorine, iodine, and bromine inhalations have not realized the hopes with which they were introduced. Also inhalations of oxygen and ozone are founded on false assumptions, and are not to be recommended; neither is the inhalation of hot air.

Salt Springs.

The inhalation of the saline air at salt springs loosens the phlegm and allays the cough. It contains all the ingredients of good breathable air, oxygen 20.7 per cent., nitrogen 78.8 per cent., carbonic acid .03 to .04 per cent., water vapour .47 per cent. To this is added from the trickling brine small crystals of common salt, and a certain quantity of ozone, hydrogen, hydrogen peroxide, and other gaseous bodies. It is still an open question whether the radio-active substances contained in salt water springs have any effect.

The effect of the air at the salt springs is materially assisted by the refreshing coolness produced by the evaporation. This produces a stimulation of the respiratory centre, with an increase of the respirations, so that the lungs absorb more oxygen and give out more carbonic acid, with a beneficial effect on the circulation and the blood. In this way may be explained the good effect of the salt springs on the mucous membranes and the general constitution. If, as is intended, the inhalations at the salt springs can be combined with an open-air treatment, then a more permanent effect may be obtained. It may, however, be asserted without fear of contradiction that tuberculosis cannot be cured by a short course lasting three to four weeks of daily walks to the salt springs.

To sum up, we may say that the inhalation of powders, fluid, vaporized or gaseous medications have a subordinate value in the treatment of phthisis; and that we must therefore be more sparing of their use than hitherto, especially at health resorts.

VI. The Pneumatic Treatment.**Active
Pneumatic
Treatment.**

From what we have said before on the importance of sparing the lungs, it is only natural that we should shudder at the active pneumatic treatment of pulmonary tuberculosis by means of breathing compressed air with a Waldenburg or other apparatus. We need not decide here whether it is of prophylactic value in cases of phthisical tendency, or whether "it is equivalent to a stay in the mountains" (Waldenburg). For us there is not the slightest doubt that the maximal respiratory movements with the apparatus, even if quite correctly used, are fraught with danger for the tubercular patient. It is a fact that damage to the lung and hæmorrhage have been observed. Also there is the danger of infecting the healthy parts of the lung by the deep breathing; and the fear of the transference of infection is not removed by giving each patient a separate mouthpiece.

**Passive
Pneumatic
Treatment.**

We are not much less averse to the passive pneumatic treatment, the use of compressed air in pneumatic chambers. As a prophylactic measure it may be unreservedly recommended, but in cases of pronounced disease it is not of curative, but only of symptomatic, value. Because of this the indications for its use must be carefully looked for.

The effects of compressed air are antihyperæmic and antitarrhal; at the same time the breathing becomes slower and deeper. For these reasons the use of the pneumatic cabinet seems indicated in cases of dry catarrh, accompanied by a swollen condition of the mucous membrane; for those forms of tuberculosis with a moderately plentiful and tenacious secretion; and for cases with atelectases of the lung tissue. For the last condition, which is often a relic of pleural effusion, the passive pneumatic treatment exceeds in its results the methodical breathing exercises. But great care must be taken in ordering its use; above all, attention must be paid to the condition of the lungs. Unconditional contra-indications are given by fever, cavities, pleural irritation, and hæmorrhage, or even a tendency to it.

**Treatment
with Masks.**

The principle of the treatment with Kuhn's mask is the same as that of the pneumatic treatment. A celluloid mouthpiece, firmly fixed round the nose and mouth, permits the gradual increase of obstruction to inspiration, which must be performed through the nose, by means of adjustable ventilation holes, whilst expiration through the nose and mouth is unimpeded. By this means the pressure of air in the thorax is reduced, and as a further result an aspiration of blood into the pulmonary area ensues. The treatment on this account must not be combined with breathing exercises, to which, in fact, it is opposed in principle, as the hindrance to inspiration diminishes the expansion of the lungs, and puts the lungs as far as possible in a state of rest. In this way practically the same treatment is applied to the lungs as Bier's aspiration glasses perform for other parts of the body: hyperæmia of the lungs is produced with an increased production of lymph. The physiological effect is an increase of the pulmonary circulation, followed by an augmentation of the blood corpuscles, improvement of the heart's action, and deepened respiration. With the increased flow of blood and lymph through the lungs a greater amount of toxin is carried into the general circulation, so that, according to Kuhn, treatment with his mask leads to a process of auto-inoculation.

The first effects on the diseased lung are decrease of the

cough, sputum, and dyspnoea, which are followed later by connective tissue growth round the tubercular nodules. At the same time, in consequence of the diminished diaphragmatic movement, adhesions of the cicatrizing tissue are prevented, and the upper part of the thorax becomes enlarged and mobilized. Kulm recommends the mask particularly for slight and medium cases of pulmonary tuberculosis as an aid to the general treatment. Bad results have not been observed by him. Slight rises of temperature of $.5^{\circ}$ to 1° F. at the commencement of the mask treatment disappear spontaneously during the continuation of the treatment.

The theoretical basis of the treatment is in accord with the results of animal experiments. Clinical observations show that there is an increase in the number of red blood corpuscles, and with less regularity of the amount of hæmoglobin. Also increase of the blood-pressure and of the capacity of the lungs, though generally to a smaller and less lasting degree, have been observed. Though the symptoms usually diminish on account of the favourable influence on the cough and breathing, a marked improvement in the physical signs, the fever and the body-weight are not usually obtained.

Thus the treatment with the mask, although it produces an improvement of the symptoms, does not succeed in producing a cure. The few cases in which an improvement in the physical signs occur during the use of the mask do not seem to us to be sufficient to prove the value of the treatment. An objective improvement of the disease should occur with fair regularity, but this, according to the observations of ourselves and others, has certainly not been the case. We limit ourselves in the use of the mask to cases with clear indications; it seems to us of value for dry cough and for regulating the breathing of difficult or refractory patients.

Bad results, particularly hæmorrhage, we have never seen from use of the mask. Patients with marked heart weakness and those with a tendency to fever are not suitable for the treatment. The mask is first applied with the apertures fully opened for half an hour three times a day; the duration of the application and the amount of obstruction to inspiration are gradually increased.

VII. Climatic Treatment.

The climatic treatment of consumption has long been highly esteemed by doctors, and still more by the laity. But even to-day our knowledge is very defective of the influence on tubercular

cases of climate, air, warmth, sunshine, damp, barometric pressure, winds, in short, of all the climatic factors. We do not even know if sunshine and good weather have any direct influence apart from their effects on the mind of the patient, or if rain, fog, or wind are directly injurious. We must therefore be still guided by experience. This teaches us that one patient may be benefited by a high altitude, another by a stay in the desert, a third by treatment at a low level, and a fourth by sea air; all of which climates may be unsuitable for other patients. It therefore follows that there exists no climate suitable for all cases. But if no single climate has specific healing power it shows that a patient can be cured in any climate. This does not exclude the possibility of one climate having an advantage over another, or of certain symptoms of tuberculosis being favourably influenced by different climates. The reaction of the consumptive to climatic influences must also be considered. These reactions consist of alterations of nutrition and assimilation which follow every change of place. The alteration may only affect the skin in some of the milder climates; others may make demands on every organ and system, particularly on the respiratory organs. Therefore the indications and contra-indications of the different climates must be considered for each individual person. The doctor who sends his tubercular patients away for treatment has the difficult task of individualizing the case, especially if he orders a stay in the mountains. He must be guided by his knowledge of the various climates and by the presence or absence of contra-indications. It might seem that a very frequent change of climate is desirable; but this is not so, because it is impossible to foresee the effects of a change of climate and because "The way in which the treatment is conducted is more important than the place" (F. Wolff).

According to the position and the height above sea-level we may distinguish (1) mountainous, (2) low level, and (3) sea climates.

A. Mountain Climates.

Mountain climates include high altitudes (over 4,500 ft.), medium altitudes (2,500 to 4,500 ft.), and moderate altitudes (under 2,500 ft.).

High Altitudes.

The most important elements in the climate at high altitudes are the diminution of the atmospheric pressure, the warmth and intensity of the sun heat, the great actinic power of the sun-rays, the rapid changes of temperature, the dryness of the air, freedom from dust and germs,

in winter marked stillness of the air, intense light and many bright and clear days, and finally increased amount of *ozone*, especially in the winter. The effects on the patients are increase in the pulse frequency and of the capacity of the lungs, augmented flow of blood to the skin and lungs, increase in the loss of heat and water vapour, improvement of the appetite, alterations in the nutrition and a relative increase of the blood-corpuscles with slight augmentation of the hæmoglobin.

The mountains also have a high value in increasing the powers of resistance of the patient, as they intensify all the organic changes. But as the capacity of adjustment of a tubercular patient is inferior to that of a healthy person he will not always be able to stand the effects of the high altitude. Therefore we must carefully consider the indications and contra-indications for treatment in the high mountains, which we, following Egger, consider to be as follows:—

Indications: (1) Prophylactic and hereditary tendency and latent tuberculosis; (2) tubercular catarrh of the lung apices; (3) tubercular infiltration of the apices; (4) commencing processes of breaking down of the lung; cavities with only slight loss of substance and without rapidly progressive disease or continued fever; (5) non-purulent pleural effusions which show only slight tendency to absorption.

Contra-indications: (1) Rapidly progressive disease; (2) extensive mischief in both lungs, even if only of a chronic nature; (3) advanced laryngeal mischief; (4) albuminuria or marked diabetes; (5) extensive emphysema; (6) heart failure and arteriosclerosis; (7) alcoholism.

It may also happen that on trial of the treatment it is found that the patient is constitutionally intolerant of the high mountain climate, or suffers from obstinate diarrhoea or asthmatic attacks, the latter usually in consequence of emphysema or cardiac dilatation, since true bronchial asthma is, as a rule, very favourably influenced by high altitudes.

The mountains possess no specific power of healing tuberculosis, neither do they confer an absolute immunity. It may be said that all the essential factors of the constitutional treatment, namely, a prolonged stay in pure, dry, open air, in sunshine and in light can be very suitably obtained, of course, for the proper patients, by a rest cure in the mountains. On the other hand, it may produce cardiac symptoms or acceleration of the disease in over-excitables, anæmic or elderly patients, also in those with already damaged hearts.

Whether the mountains have a particular influence on certain

symptoms of pulmonary tuberculosis is not yet decided. From the rare occurrence of septic infection in the mountains it appears that they have a restraining influence upon mixed infection and its consequences. Fever and night sweats may perhaps be more quickly removed; hæmorrhage is not more frequent, but on the other hand more rare than at low levels. It is not yet sufficiently proved that there is a more rapid drying up and calcification of caseous nodules. The differing opinions upon this may be due to the variability of the disease, and perhaps partly to lack of experience. One need not be prevented from sending a patient with a tendency to hæmorrhage to the mountains by a false analogy between high mountains and very rarefied air, which latter may induce hæmorrhage even with healthy persons. There is also, as Turban rightly remarks, a difference between the mountain health resorts 4,000 to 6,000 ft. high and balloon ascents to an altitude of 15,000 to 20,000 ft.

The winter is the most advantageous time of the year for the mountain treatment, although Davos was first employed as a summer resort by Alexander Spengler. But the consumptive may remain the whole year in the mountains if the necessary precautions are taken during the transition period. The widespread idea that the spring with the melting snow gives rise to acute illnesses Turban has shown to be inaccurate. According to his opinion, not only the patients in the disciplined sanatoriums, but also those in the hotels, &c., at Davos, suffer much less in the spring-time from acute illnesses than the patients in the regular spring stations lower down.

The most important places for the treatment of pulmonary tuberculosis are: Davos (Grisons, 5,200 ft.), Clavadel (Grisons, 5,200 ft.), Arona (Grisons, 6,200 ft.), Sils Maria (Upper Engadine, 5,800 ft.), and Leyen (Vald, 4,100 ft.). Summer cure resorts for slight stationary tubercular cases are to be found in the Upper and Lower Engadine, in the Bernese Oberland and in the South Tyrol.

The climate of the medium altitude has the same effect on tubercular patients as the Alpine resorts, without being so marked in its effects. The resorts at this altitude produce a hardening of the patient and regulate the nervous system, the appetite, and the nutritional changes; and as they do not suffer from the same brusque changes in temperature as the high mountains they permit a more extended employment of the open-air cure.

With regard to the indications, it need only be said that seriously ill, hectic consumptives, and those with severe complications, cannot be sent to the medium altitudes any more than to the high ones.

The choice of the time of year for treatment at these altitudes is of less importance. It can be carried out in summer and winter with equally good results, provided that the place is properly adapted for receiving visitors in the winter.

Among the places of an altitude of 2,000 ft. or more we may name St. Blasien, Todtnau, Triberg, Schweigmar (in the Black Forest), Obertal in Thuringia; Les Avants (near Montreux), Gossens (Breuss) Glion and Caux (Valais), Weissenburg (Bavaria), Bestenberg (Thuringia), Châtaignard (Grisons), Heiden (Appenzel), Bürgenstock and Engelberg (Unterwalden), Oberdorf (Argov), Partenkirchen and Kaimersbad, Mittenwald, Bad Krenn, Berchtesgaden, in the Bavarian Mountains.

Moderate Altitudes.

The lower mountain resorts make no great claims on the organism. Their climatological merit consists chiefly in the scarcity of germs in the air and in their position on a plateau, slope or valley. In many of these resorts the proximity of mountain lakes produces a uniformity of the temperature and a certain moisture of the air. These lower mountain resorts are of a certain importance as intermediate stations between the high mountains and the plains. There are a large number of them in almost all countries. We will only mention the most important —

Suitable for the autumn are Gries and Bozen, Meran and Obermeran (Tyrol), Valin (Brixen), Montreux and Vevey. There are many summer cure resorts on the Lakes of Lucerne, Thun and Brienz (Switzerland), Constance and other lakes of Bavaria and Austria, in the Black Forest, the Taunus and Harz Mountains; such places are Immenhausen, Isch, Reichenhall, Badenweiler, Bad Ischl, Zell, Talsatz, Salzungen. Most of these places are for summer cure only, the season lasting from May to October.

B. Climates at a Low Altitude.

Of the climates at a low altitude we may distinguish places in the temperate zone, the Italian lakes, the deserts, and the sea-coast.

The Temperate Zone.

The lower levels of the temperate zone have no characteristic climatic influence, as the places vary greatly; sometimes the climate is of the continental type, sometimes the influence of the sea predominates. As regards warmth and moisture the climate of the German plains is "cool and moderately damp." Extremes do not exist, being modified by the neighbourhood of hills, forests, or the sea. The forests especially affect the temperature, moisture and light, and differentiate the climate from that of the bare plains. They also shelter from the wind and are associated with that fresh, pure, dust-free air, so necessary for the consumptive. Wherever these conditions prevail, where the soil

and water supply is good, and where the proper constitutional measures, especially rest in the open air, can be thoroughly carried out, there are all the conditions necessary for the cure of tuberculosis. This is shown by the success of the German sanatoriums in hilly, wooded, sunny positions, sheltered from the wind, and with pure ozone-containing air; on this subject we need say no more.

The Italian Lakes.

The low-level climate of the lakes in Northern Italy and the adjoining part of Switzerland is moist and warm. The great expanse of lakes, certainly in winter, makes the air warmer, and in the changes of seasons tends to maintain a fairly even warm temperature. The best times to visit these agreeable resorts are spring, autumn, and winter; summer, in spite of the cooling effects of the lakes, is much too warm. There are no special indications or contra-indications. Slightly febrile patients with fairly advanced disease often do better here than in the high mountains.

As spring, autumn, and winter stations, may be mentioned Gardes-Riviera and Fasano (Lake Garda), Arco (one mile from Lake Garda, in winter only), Lugano (Lake of Lugano), Pallanza and Locarno (Lake Maggiore), Cadenabbia (Lake Como), Wengen and Vitznau (Lake of Lucerne).

Desert Climates.

The climate of the desert, which is generally only suited for consumptives in the winter, is warm and dry. The most important are the health resorts of Egypt, the Soudan, and the Biskra oases in Algiers. Their chief merits are copious sunshine and aseptic air rich in ozone; their disadvantages are great variation of temperature, violent dry winds and severe dust storms. The dry air is an advantage for patients with profuse secretion and a propensity to bronchial catarrh, also for kidney complications; on the other hand, these places are not suitable for patients with dry catarrh of the upper air passages or tuberculosis of the larynx. Plehn originally recommended the climate of Egypt especially for persons who had contracted tuberculosis in the tropics, and that indication still holds good. Weak powers of resistance, advanced tuberculosis, fever and heart affections are contra-indications. In recommending such a climate the long, fatiguing and costly journey must be considered, and arrangements must be made for suitable medical supervision of the patient.

As winter health resorts of this class we may mention Helwan (seven miles from Cairo), Luxor, Assuan, and Mena House (at the pyramids, all in Egypt).

Dry Coast Climates.

Island and seaside resorts, with a warm, dry climate, and only moderate or slight moisture, are suitable for the winter, and are sedative in their action. To them may be sent patients with excessive catarrh of the mucous membranes, for whom the mountains are contra-indicated. On account of the dangerous distractions that are often to be found, great caution should be used in selecting these places; we need only mention the gaming-tables of Monte Carlo, and the fast life of Nice. Also on the Riviera, the hygienic conditions are often defective, the dust from the great automobile traffic is intolerable, the air is frequently too dry in spite of the proximity of the sea, and there is often insufficient protection against the cold of February and March; but in spite of these drawbacks it maintains its popularity.

Representative examples of this climate are Corsica, Santander, San Sebastian, Biarritz, Arcachon, Ajaccio, Capri, Palermo, Corfu, Abano; on the Riviera di Levante, Rapallo, St. Margherita, Nervi; and on the Riviera di Ponente, Cannes, Nice, Mentone, and Hyères, in France; and Orsdelotti, Bardighera, San Remo, in Italy.

C.—Sea Climates.

Maritime climates are noted above all for the uniformity of the temperature, and pureness and saltiness of the air; in which may be added high atmospheric pressure and strong atmospheric currents. On strong patients they produce a stimulation of the nutritional changes, a retardation of the pulse, and quietening of the nervous system; while with weak patients loss of appetite, diarrhoea, sleeplessness and hæmorrhages are not uncommon. But the most important effect of the sea climate is that the respiratory quotient falls.

According to the temperature and relative dryness of the air we may distinguish the cool, moist climate of the North Sea, the milder, warmer, sea-coast climates, and the real ocean climate.

Climate of the North Sea.

For treatment by the climate of the North Sea patients must be carefully selected. Besides altering the gaseous exchanges, this climate has a marked effect on the circulatory organs, which shows itself regularly by increase of the blood-pressure, a slowing of the pulse, and diminution of the albuminous contents, the last in consequence of increased muscular work while taking the sea-baths. We consider the North Sea climate specially suitable for prophylactic treatment and also for persons suffering from tuberculosis of the bronchial glands or initial pulmonary tuberculosis without fever or hæmorrhages. It may further be used for cases

of chronic stationary phthisis, for early laryngeal tuberculosis, and for cases complicated by non-tubercular chronic catarrh of the upper air passages and bronchial tubes. Healthy digestive organs are essential.

Unsuitable are (1) very excitable patients; (2) febrile cases; (3) cases of caseous pneumonia, cavities, profuse secretion and hæmorrhages; (4) advanced laryngeal tuberculosis; (5) cases with tuberculosis of other organs, intestine, kidney, &c.; (6) cases complicated by marked cardiac, gastro-intestinal or nutritional changes, and markedly neurotic patients. The North Sea resorts have their greatest importance for the treatment of scrofula and surgical tuberculosis of children.

**Milder and
Warmer
Sea Climates.**

Coming under the influence of the Gulf Stream the resorts on the south and west coasts of England and Ireland are warmer and milder than those on the North Sea, and therefore are more suitable for cases with severe catarrh of the upper air passages. As examples we may mention Ventnor, in the Isle of Wight, Bournemouth and Torquay.

Still less stimulating and more sedative are the warm maritime climates of more southern islands. Types of these are Funchal, in Madeira, and Orotava, in Teneriffe.

Sea Voyages.

The real ocean climate can be made use of by means of sea voyages. Although known in Pliny's time, it is not yet agreed whether sea voyages should be ordered for consumptives, in spite of the undoubted advantages of pure air free from dust and bacteria, continual atmospheric movement, comparative rest, and ample sojourn in the open air. It is agreed that they have a remarkably stimulating effect in cases of bodily weakness and psychical disturbance. The changes of scene and climate divert the mind, raise the appetite and accelerate tissue changes. The skin, lungs, and all organs which react to changes to temperature are exercised and hardened. Also the large amount of moisture, salt and ozone in the ocean air is advantageous for some cases of tuberculosis. On the other hand, there are drawbacks, such as scarcity of space in the cabins, monotonous nourishment, and fear of prolonged sea-sickness. In long sea voyages, involving changes of climate, too sudden changes of temperature and excessive air currents are also to be feared. Moreover, the social conditions under which the passengers must live and the absence of expert treatment and medical discipline are disadvantageous. The question of the construction of ship sanatoriums has been discussed in different countries, but has had no practical result, in spite of the recom-

mentation of medical authorities and the attempts of powerful marine companies. Although the idea of floating sanatoriums under medical supervision has much that is good, there are too great difficulties against its practical undertaking. Also from a medical standpoint, this kind of thalassotherapy for tuberculosis can only be recommended within very narrow limits: the patients must be very carefully chosen and those with a strong disinclination against sea voyages must in no case be over-persuaded. They are only suitable for strong patients free from fever, hæmorrhages or complications, and with sound nervous and digestive systems. For consumptive doctors, the popular proceeding of taking a post as ship's surgeon is always rather hazardous: if the doctor is capable of work he will do better to take a post as assistant in one of the many land sanatoriums.

In the choice of the sea route one must have regard to the wishes of the patient as much as possible: in spring and winter the voyage is generally rougher, in winter also the changes of climate seem more brusque than in spring and summer. It is worthy of notice that ocean currents and the propinquity of the land influence the temperature of the air, and give the sea voyage a cool or hot character. Voyages interrupted by frequent and long land visits are not at all suitable for consumptives, they only allow an opportunity of contracting malaria or other infections.

Mediterranean voyages are suitable for the winter, and for the summer trips up the Norwegian coast to the North Cape, or longer voyages to Australia, New Zealand, West Indies, North America, &c.

Colonies and Tropics.

The question may arise of making use of the Colonies and the Tropics. It may be known that some years ago, under the influence of a well-known physician, a movement was started to build sanatoriums in South-West Africa, and to send there German tubercular working-men at the cost of the National Insurance Companies. After the cure they were either to be brought back home or to remain in the Colony. The plan fell through and the committee dissolved, so we have nothing further to expect from either. It is the experience of the Cape Colony that the tubercular patients were regarded uneasily by the natives: it appeared that for one white tubercular patient who died there were six deaths among the native population, in spite of the very favourable climate. This was due to the small power of resistance to the new disease and to the bad hygienic conditions, crowding together, indiscriminate spitting, drinking, &c.

The conditions in Cape Colony are a warning against sending tubercular lung cases to German Southwest Africa. Kahn says that "the Colony has nothing to fear for the health of its inhabitants, for the greatest prudence reigns among the tubercular immigrants"; but the greatest prudence in this case is the keeping away of all tubercular persons. Similar conditions prevail in the other German colonies. We have every good reason to keep and treat our tubercular patients at home, both in the interests of the patients themselves, and for the political, economical and hygienic advantage of the colonists. We want healthy colonials, physically strong and energetic, but not early phthisical cases or persons sent out as a prophylactic measure.

VIII. Watering Places.

The treatment at watering-places is a combination of the climatic treatment with the medicinal effects of the waters. But the climate at these watering-places is often very unsuitable, either because these resorts are generally situated at a low altitude and are neither bracing nor sedative, or because they have usually developed into towns, which with their industries have vitiated the purity of the air. The medical treatment is limited to the prescription of the waters of the place, either internally or externally in the form of baths; or, in addition, whey, k&icaron; or grapes may be ordered.

Mineral Springs. Used as baths mineral water has no special effect on the consumptive, at any rate, no more than the ordinary warm bath.

The value of the internal use of the natural mineral waters in the treatment of consumption is also very doubtful. Some lay great stress on the efficacy of drinking the waters, others believe that they are of no more value than an equal amount of tea or warm water. According to our own observations at one of the springs most frequented by tubercular cases, the use of the waters is no specific remedy against the disease. It is not established that the treatment with mineral waters, without the use of other methods simultaneously, has any healing effect. The fact that in healed tubercular nodules lime salts are deposited does not warrant the assumption that taking water containing lime is to be recommended, since the ordinary nourishment supplies enough lime salts for that purpose. On the other hand, one may concede the fact, that the mineral waters used for cases of tuberculosis may, from their composition and temperature,

have some local or general action on the affected organism; to explain this the general chemical laws of osmosis and diffusion are sufficient, without invoking the radio-activity of the water.

The mineral waters affect the chemical changes of the blood by altering the osmotic pressure of the tissue fluids, from the regular ingestion of considerable quantities of salts in solution. By this means the results of the tissue changes are more easily eliminated, partly by absorption, and the destruction of diseased cells with the formation of new ones with increased resistance is hastened.

It may therefore be urged that the treatment with mineral waters is capable of regulating the digestion, of increasing the action of the kidneys and mucous membranes, and of accelerating tissue changes; and that it may be legitimately employed as an aid to the general constitutional treatment.

Thus it is not correct to deny that the mineral waters have any influence whatever in combating pulmonary tuberculosis; but it is still more incorrect to assert that they are of essential importance, and that they can replace the general hygienic treatment. We agree with the opinion of Penzoldt that the treatment of tuberculosis by mineral waters, when accompanied by other general treatment, is *admissible*, but that it is also *unnecessary*. But we see that there is no small danger in its use if doctors and patients, in blind confidence in the mineral water treatment, "neglect the important for the unimportant," that is to say, allow a course of waters and baths lasting four to six weeks to replace a strict and regular hygienic treatment.

We need not consider the individual springs and baths. It is sufficient to say that those resorts will be of most service where drinking the water can be combined with properly regulated constitutional treatment, always provided that the duration of the treatment is not too short. For it is one of the claims of those interested in the mineral water treatment that this method gives quicker, and therefore better, results than any other.

As regards the indications for this treatment, we take the standpoint that persons should not be sent for reasons of prophylaxis to any resort for consumptives, on account of the possibility of infection. The recommendation of a suitable watering-place may come into question for cases of closed tuberculosis, who are suffering from non-tubercular chronic diffuse catarrh, or changes in the lower lobes of the lungs. The cases of open tuberculosis that are most suitable are those patients without fever, who have already been disciplined by a proper hygienic treatment, and who will no longer suffer institutional treatment,

or who have some special complication, which may be relieved by the use of the waters.

**Whey, Kéfir, and
Grape Treatment.**

The whey must be prepared from fresh goat's, cow's, or sheep's milk by removing the casein and fat by the addition of rennet. Its nutritional value is small, and its therapeutic worth nil, or even a minus quantity, since the whey may produce slight catarrh of the bowels. The resorts for treatment with whey are not fit places for tubercular patients.

Kéfir, that is to say, cow-milk that is undergoing alcoholic fermentation from the action of the kéfir ferment, may be a useful aid to nutrition in cases of repugnance against ordinary milk, or when pure milk is not obtainable. It may be also used to regulate the bowels, since fresh kéfir is a laxative, while that three days old is constipating. It has no value as a curative agent. Kéfir can be prepared anywhere by the help of an artificial ferment; we recommend the kéfir tablets for private cases. There is no need of a kéfir cure resort.

The grape cure can be taken on the Rhine, in Alsace, on the Lake of Geneva, or in Silesia, Austria and Italy, during the months of September and October. One to four pounds of grapes must be taken daily, without skin or pips. The treatment may increase the appetite and power of assimilation, but it also causes loosening of the teeth, sore mouth, and gastric and intestinal disturbance. The grape cure and grapes-cure resorts may be very well left on one side.

IX. Symptomatic Treatment.

Fever.

Of all symptoms, fever is the most frequent and the most serious; it is also the most difficult to fight.

Like other persons, a consumptive may suffer from fever, which has no connection with tuberculosis of the lungs. Acute tonsillitis, appendicitis, acute intestinal affections, rheumatism and influenza may be mentioned; in the treatment of which the condition of the lung must be taken into account.

More often fever is due to a catarrhal infection of the upper air passages, bronchial tubes or alveoli; that is, the fever is due to changes in the lungs, but not to the tubercular mischief. In these cases great care is necessary lest the mixed bacterial infection should open up fresh pathways for tuberculosis, and give rise to fresh tubercular foci. Every such case should have rest in bed on a fever diet. A radiant heat bath, and several doses

of calomel (3 gr. every two hours) to produce diuresis and empty the bowels, will generally shorten the fever.

The rises of temperature which precede or accompany menstruation in tubercular women have a definite pathognomonic importance; as have also the sudden rises of temperature associated with severe physical or mental exertion; they are known as menstrual, exercise or psychological fevers. The treatment consists in quieting the over-excitable nervous patient, and in ordering bodily and mental rest. Preparations of valerian are harmful.

A few words may be said on the diagnosis and measurement of tubercular fever. The temperature curve must be based on measurements taken every two to three hours. If it rises to 99.2° F. in the mouth, or to 99.6° F. in the rectum, there is fever, or, taking individual differences and possible sources of error into consideration, at least suspicion of fever. We consider that three hourly measurements at 8 and 11 a.m. and 2, 5 and 8 p.m., taken in the mouth, are sufficient. Useful information as to the temperature after eating is thus obtained. It may be further noted that a temperature of 99.2° F. in the morning is fever; and that a temperature that never falls below 98.6° F., and one which varies more than two whole degrees between the minimum and maximum, is not normal.

In patients who are nervous and excited about their temperature, it should be taken by a nurse with a non-registering thermometer in the rectum. Very feverish patients should never take their own temperature.

A knowledge of the biological significance of fever is important for its treatment. According to our latest knowledge the rise of temperature, which accompanies infectious diseases, is to be considered as a reaction against the cause of the illness, and as an aid to the organism for more quickly and powerfully freeing itself from the infection. Certainly fever influences favourably the vital functions of the leucocytes, and the formation of agglutinin, of humo- and bacterio-lysin and of antitoxin. From this may be learnt the lesson that in tubercular fevers it is not wise to interfere with the immunizing leucocytosis and formation of antibodies by a "routine attack on the raised temperature at any cost, the one and only indication being the height of the fever" (Richter).

It must, on the other hand, be noted that pulmonary tuberculosis being a chronic disease, even low fever temperatures, on account of their duration, have bad effects on the central nervous system, the respiratory and circulatory centres,

the digestive apparatus, the kidneys, &c. High and hectic temperatures are even more injurious. Herein lies the indication for the treatment of tubercular fevers. As it is not the rise of temperature that must be obviated, but rather its injurious results and consequences, there should be no heroic treatment of tubercular fever, with drastic drugs or external applications.

Tubercular fever is maintained at the cost of the tissues of the body, and the accompanying loss of appetite prevents this loss being made good. Therefore it is most important to limit as far as possible all forms of tissue destruction; and the sovereign way of doing this is rest in bed. The supposition that this weakens the body is erroneous. The weakness is not a consequence of the rest in bed, but of the illness which compels it. Bed must be kept till the feverishness has gone; every considerable movement, every premature getting up, postpones that due. Open-air cure can be carried out at the same time by wheeling the bed on to a balcony, or up to the window, kept widely open day and night. When the temperature has been quite normal for two to three days rising may be permitted, but at first only for one hour; if the temperature remains normal it may be extended to two to three hours. Still no walks are to be taken; the effort of dressing and undressing, and walking to the reclining chair and back, is sufficient. If the temperature rises in the afternoon, even one-tenth degree above normal, the fever has not gone, and the strictest rest in bed is again necessary. It may be required for weeks and months, but the strictest rest leads to the desired goal most surely. Only under certain conditions may these rules be relaxed—e.g., in hopeless cases, in patients whose surroundings are so unhygienic that rest in bed entails bad air, or in chronic fever and cavity cases, in which the long rest is depressing the appetite and spirits, and hindering the expectoration.

The food of feverish patients should be ample, but easily digestible. Fever diet should not be a hunger diet; on the contrary, by frequent additions to the diet, and by skilful cooking, one should try to supply the requisite number of calories. This is not easy when the appetite is bad. Stomachics, condurango, pepsin in mixture with hydrochloric acid and tablets, *orexinum tannicum* (4 gr. in powder or tablets, three times a day), and tonic wines, containing relatively little alcohol and much meat extract, may be useful. As a beverage, milk, with or without cream, and kôfir are to be preferred.

Alcohol is often of the greatest service. A glass of wine

may be given at meal-times, especially at the beginning of the fever. A glass of hot grug or mulled wine an hour before the usual shivering is very useful in hectic fever; at the same time an ice-bag should be applied to the heart, and the patient well wrapped up.

Of hydro-therapeutic measures, there are chest packs, friction of the skin with alcohol or damp towels, and prolonged bathing of the hands and arms with water not too cold. These measures, besides helping to lower the temperature, will stimulate the organic functions.

Antipyretic drugs must be very carefully ordered, lest they do more harm than the fever. They are only indicated if the subjective symptoms are severe, or the fever prolonged; otherwise it is better not to interfere with the defensive mechanism. It is best, as far as possible, to give the drug before the rise of temperature. At the height of the fever it must only exceptionally be ordered, and then only in small doses, so as to avoid producing profuse sweating and collapse. For the same reason antipyretics should never be given with a falling temperature.

We only give a small list of the many recognized antipyretics. Quinine has been generally given up. Salicylates have, by the addition of arsenic, been brought back to favour (acid. arsen. $\frac{1}{2}$ gr., sod. salicyl. 130 gr., D. pil. 100, two to be taken three or four times a day). These pills cause a slow fall of temperature without after-effects, but sometimes they produce noises in the head, and indigestion.

More frequently used are aspirin (4 to 7 gr.), antifebrin (3 to 4 gr.), antipyrin (7 to 15 gr.), lortophenin (7 to 15 gr.), and citrophen (7 to 15 gr.).

We give the preference to phenacetin (4 to 8 gr.), salipyrin (15 gr.), and especially pyramidon. Salipyrin is particularly useful in febrile disturbances associated with menstruation, and in sleeplessness due to evening or nocturnal rises of temperature. Phenacetin acts promptly and well, and is without after-effects; it is specially serviceable if there is headache at the same time.

Pyramidon is the antipyretic *par excellence*. It requires about two hours for its action, which takes place imperceptibly and gradually, and without unfavourable effects on the heart. In continued fever one can give repeated doses of a tablespoonful of 1 in 100 pyramidon solution in water. In cases of irregular fever 2 to 3 gr. of pyramidon may be dissolved in a glass of water and drunk in mouthfuls extending over half an hour, commencing about two hours before the rise is expected. If the fever is causing loss of appetite it is recommended to give this

drug (two hours before the chief meal). Sometimes after a long course of pyramidon the fever does not return, sometimes it returns again when the drug is intermitted; if the fever is quite uninfluenced the prognosis is very bad.

About maresin and phthisopyrin tablets there are both good and bad reports; W. Heubner expressly warns against the former, which, according to his observations, is a strong blood poison.

The chief point in the treatment of fever by drugs, no matter which is employed, is that small doses must be given at the right time to prevent the rise. But the patient whose temperature is artificially kept down by drugs is by no means to be considered as free from fever.

Recently reports have multiplied of the good effects of treating the cause of the fever with tuberculin, especially Koch's new bacillary emulsion. But this method, although it strikes at the root of the fever and not merely at the symptom, cannot be always used. The treatment begins with the smallest doses, the first dose of the new bacillary emulsion being about 200 c.mm. We may refer to our book on "Tuberculin in Diagnosis and Treatment."

Night-sweats.

For the treatment of most cases of night-sweats general hygienic and hydro-therapeutic measures are sufficient; by themselves they usually remove the weakness of the heat centres caused by the specific toxins, and raise the tone of the vessels. The open-air treatment must be thoroughly carried out, with very complete ventilation of the bedroom, which may be heated in winter to allow this. Horse-hair mattresses and pillows are the best. Heavy coverings must be replaced by lighter woollen ones, or a light rider-down quilt. Cornet advises that the arms should be left outside the coverings, and the legs kept apart by sheets. The clothing must be changed morning and evening, and the bedding well aired every day.

Attention to the skin by means of regular baths, alcoholic or cold frictions and dry rubbing, is also important. Before going to sleep Brehmer's favourite remedy of half a pint of cold milk with a teaspoonful to a tablespoonful of brandy may be taken; or if alcohol is contra-indicated, *linel. salicæ* (20 drops t.i.d.) may be ordered.

If these measures fail in severe cases then the patient may be washed all over every evening with dilute brandy or vinegar (also 2 to 5 per cent. lysolform used morning and evening has given us good results in bad cases. Afterwards tannoform (tannoform 1 part, talc 2 parts) must be rubbed into the skin with the palm of the hand. There are no advantages in the use of formalin with alcohol or soap.

Of the internal remedies atropin and agaricin are to be recommended. Atropin may be given in the form of pills (1/240 gr. in each), two at night, or two in the morning and two at night. If the digestion is disturbed it must be given subcutaneously (1/300 to 1/60 gr.). Toxic symptoms, such as dryness of throat and dilated pupils, must be guarded against; the maximum dose must not be exceeded, nor given for more than several days together.

Agaricin requires about six to seven hours to act and often causes diarrhoea; and it may therefore be well combined with Dover's powder in pill or powder form (agaricin $\frac{1}{4}$ to $\frac{1}{2}$ gr., pulv. Doveri $\frac{1}{2}$ gr.). It may be given for many days together, but is contra-indicated from the first for patients with disordered digestion.

Acidum camphoricum (15 to 30 gr. a dose) and guacamphol (3 to 7 gr. in the evening) have been of less service to us than pyramidonum bicanphonium (Höchst), with which, in doses of 10 to 15 gr. several times a day, we were well pleased. If there is also sleeplessness, sulphonal (15 gr.), veronal or sodium veronal (4 to 7 gr.), or adalin (7 to 15 gr.) must be ordered for several evenings in succession in a warm drink.

It must be remembered that all these remedies have only a symptomatic value, and that they must fail if proper hygienic measures are not taken.

Cough and Expectoration.

A distinction must be made between cough with and without expectoration, and also between reflex and irritative coughs.

The dry cough of early phthisis may be suppressed with a little effort and discipline; it has more importance for diagnosis than treatment.

The loose cough is regulated by the state of the lungs. It is usually most marked in the morning, because the secretions have accumulated during the night.

The reflex cough that is necessary for bringing up expectoration must not be checked without a reason. The patient who brings up his expectoration with but little cough during the morning "toilette of the lung" would not be helped, but rather injured, by suppressing the cough. It is only to be seen that the cough and expectoration are in the right proportion, and that the cough is followed by the latter. The only useful treatment will be that directed towards loosening the expectoration.

In many cases there is an irritative or spasmodic cough, which is started perhaps by the tubercular foci in the lungs, but which is aggravated into attacks of continuous, convulsive, or explosive coughing by catarrhal complications in the mucous

membranes of the upper air passages and larger bronchi. This cough must be combated by all the means at our disposal, as it disturbs the night's rest and nutrition of the patient, and prevents the lung from healing by stretching the tissues. Every continuous violent cough must be treated for several reasons. It causes pains in the muscles of the chest, vomiting, and possibly hæmorrhage or pneumothorax. It may force sputum containing bacilli back from the tubes into healthy alveoli, and in short injures the patient both bodily and mentally.

The patient must be instructed to discipline the cough as far as possible. He must be told that "coughing causes coughing" (Penzoldt), and that he may by will-power overcome the first tickling in the throat. According to Cornet, about ten very slow inspirations with more forcible expirations are very effective in controlling the irritation. Pure air, rest to the voice, breathing through the nose, sips of hot or cold drinks, Ems pastilles, Iceland moss, menthol, eucalypt, and other lozenges, dragées and pastilles are useful.

If these measures fail we may order several days' rest in bed, in a room in which the moisture is increased by steam, or by sprays of salt solution (one teaspoonful to two pints), or of sodium carbonate solution (1 to 2 per cent.), or by hanging up damp sheets. Complete silence, chest-packs, alkaline water alone or with milk, and, as a last resource, opiates, may all be used.

We have had so few good results from *cannabis indica*, *tinct. gelsemii*, *ext. hyoscyami* and *paraldehyde* that we have given them up for some years.

We have found *dionin* (*ethyl-morphia-hydrochloride*) and *codeine phosphate* to be the most useful; they act as local and general sedatives and favour sleep, without checking the expectoration or causing constipation. In this, and the fact that they are less poisonous and less likely to cause a habit, lie their great superiority over *morphia*. For children they may be ordered in the form of a syrup (1 in 100, a teaspoonful in the evening), for adults as drops (3 to 4 gr. in 500 of water, or *aq. laurocerasi*, 40 to 20 drops t.i.d.s. or at night), more rarely in the form of pills ($\frac{1}{2}$ to $\frac{3}{4}$ gr.) or suppositories ($\frac{1}{2}$ to $\frac{3}{4}$ gr.).

A new remedy of value is *pantopon*. Compared with *morphia* it is but slightly narcotic, and affects the respiration and heart frequency much less; but it has a strongly sedative effect on the cough. It is best given in small single doses, not on an empty stomach (for adults 10 to 20 drops of 2 per cent. solution three or four times a day, for children 5 to 15 drops).

Morphia remains as a last resource, which must not be withheld from hopeless cases. On account of its general sedative action it is particularly valuable in cases of pain, marked unrest and psychical disturbance. In these terminal cases the danger of the morphia habit need not be considered, but unfortunately this is not sufficiently thought of in early cases. All the same, one should always try the effect of small doses, and reserve the larger doses and subcutaneous injections for cases of necessity. Vomiting, occurring at meals or soon after, requires larger doses of morphia to be taken half an hour before food, or, if an injection is given, shortly before the meal.

We have already emphasized the fact that the amount of cough depends on the looseness of the expectoration, which therefore must be, as far as possible, promoted. This may usually be done by inhalations, by warm drinks, and by warm mineral waters taken fasting early in the morning, in preference to using the so-called expectorants. Of these we have the *mistura solvens* (ammon. chlor. and liquorice), ipecacuanha, senega, apomorphin, and particularly iodide of sodium; the last also may be combined with ipecacuanha and senega. Klopfer's *iodoglidine*, a combination of vegetable albumen with an organic iodine compound, acts better and is better tolerated than sodium iodide. Sometimes an opiate, as mentioned above, may be added in small doses. We have also found the new remedy for whooping-cough, *pnigodin*, a harmless expectorant.

By far the best method of loosening the expectoration, and thereby diminishing the cough, is the chest-packs of Winternitz, which we can warmly recommend. We have already described the method of applying them (p. 109). Other methods of diminishing the expectoration, and if necessary of deodorizing it, we have mentioned in the section on inhalations (p. 134). The danger of swallowing the expectoration is mentioned in another place.

Hæmoptysis. The first essential for the treatment of hæmoptysis is that patients with even very

slight bleeding must submit to complete bodily rest at once. Also we must forbid excessive mental activity, devotions to Bacchus or Venus, hot drinks, especially strong tea and coffee, and the breathing of air containing dust. If the bleeding is in any quantity complete confinement to bed is necessary, with entire mental rest. Relations must be kept away by an affusion, if necessary, to the gravity of the condition. Severe cough must be treated with a suitable drug. The food must be lessened, and non-irritating lukewarm soup and drinks given. The action of

the bowels is to be regulated with an aperient or a saline enema. The patient must not get up till the bleeding has ceased for several days.

In very severe hæmorrhage there is the possibility that coagulated blood may block the air passages; the patient becomes cyanotic and suffocated. In such a case the pharynx must be cleared out as low down as possible with the finger, then the patient is to be made to cough violently, and to drink some stimulating fluid (wine or brandy). While the patient is undergoing complete rest in bed ice-bags may be applied to the chest; also Penzold's sand-bags or Nieder's bandages of strapping may be used. The ice-bag has at the same time a sedative action on the heart. The upper part of the body must be raised with a bed-rest, in that position the lungs are freed from expectoration as easily as possible. It is important that the clots and thrombi be not disturbed. If on the doctor's arrival the hæmorrhage has not ceased he must quieten the patient as much as possible, enjoin silence, and refrain from physical examination. The old home remedy of drinking a teaspoonful of salt in half a glass of water is excellent; above all, it is always at hand. If ice can be obtained a fairly large ice-bag should be placed over the diseased or painful area, which combines the effect of cold with pressure and immobility. Later a second smaller ice-bag may be placed over the heart; while to alleviate the tickling in the throat pieces of pure ice of the size of a pea or bean may be sucked. These measures also act by suggestion. We have not seen gastric or intestinal disturbance from their use.

Bandaging the limbs, a very old remedy, is worth considering. It acts as a hæmostatic by emptying the large veins and by raising the coagulability of the blood, in consequence of hædremia of the part of the circulation which is obstructed. The middle of the thighs and upper arms are bandaged one after the other with an elastic or ordinary bandage, in such a way that the unaltered pulse shows that the arterial flow is not affected while the venous return to the lungs is obstructed; after half to one hour the bandages are very slowly and gradually loosened one after the other. Lastly a narcotic is given to diminish the bodily and mental unrest of the patient, the dry irritating cough, and the pressure in the pulmonary circulation. The substitutes for morphia may be used: Dionin ($\frac{1}{2}$ to $\frac{3}{4}$ gr.), pantopon, codeine phosphate ($\frac{1}{2}$ to $\frac{1}{3}$ gr.), and heroin hydrochloride usually act promptly if given subcutaneously. Dover's powder (3 to 4 gr.) is also useful. If restlessness and cough do not subside, morphia

is the stout anchor. Lately a warning has been issued against morphine injections in these cases from the fear of stopping the expectoration of the blood, and of inducing morphinism, which in our experience is groundless. The fear that morphia will hinder the expulsion of the pent-up blood, and so induce disease in the lower lobes, is exaggerated, and the danger of morphinism is a theoretical one. It acts both psychically by quieting the patient, and physically by lowering the blood-pressure. It is best to begin with small doses of morphia ($\frac{1}{10}$ to $\frac{1}{8}$ gr.), which allay the cough without checking the expectoration; it can be once repeated. If there is heart weakness digitalis may be given at the same time. The combination of morphia and atropine has no advantages; the addition of scopolamine ($\frac{1}{10}$ gr.) has been warmly recommended as avoiding the depressive action; we cannot support this recommendation.

No general lines can be laid down for the treatment of protracted hæmorrhage. We can only give some hints. The food must be easily digestible, and must be neither hot nor quite cold. The amount of liquid need not be much restricted, but smaller and more frequent quantities are to be recommended. Hot liquids, strong beef tea, and concentrated alcohol are to be avoided, while milk, acid lemonade, puddings containing gelatine and lime, and food that is rich in salt, but not constipating, are to be recommended. The regular emptying of the bowels is most important.

Of drugs, ergot and its derivatives, hydrastis, stypticin, styptol, liq. ferri perchlor., tannic acid, and lead acetate fail with such regularity that their use should be abandoned. If after their administration the hæmorrhage ceases it is probably an accidental occurrence, or merely the effect of suggestion. The preparations raising the blood-pressure, adrenalin and suprarenin, and those dilating the vessels, amyl nitrite and nitroglycerine, can be passed over; the former may be even dangerous, and the latter is only to be used with the greatest caution.

The coagulative action of calcium chloride (15 gr. t.d.s.) is uncertain in severe hæmorrhages; Reiche recommends it in combination with asorphine ($\frac{1}{8}$ gr.). Calcium lactate has the advantage of being tasteless. The use of a combination of sodium chloride (75 gr.) and sodium bromide (50 to 60 gr.) may be recommended; the salt increases the coagulability of the blood, whilst the bromide tranquillizes the patient (van der Velden). We give at intervals of one and a half hours alternately salt (75 gr.) and bromide (45 gr.), up to 200 to 450 gr. of salt and 180 to 220 gr. of bromide a day.

The use of gelatine for bleeding is very old; the Chinese

employed it in the third century. Recent observations have shown that gelatine does not only raise the coagulability of the blood, but that this rise persists a long time (Grau). However, the indications for its use cannot be laid down as long as we are ignorant of the mechanism by which this increased power of coagulation is brought about. Our opinion of the value of the treatment is not so high, and the results obtained are not so certain and constant, that we can feel ourselves justified in submitting our cases with hæmorrhage to an injection of gelatine, with its dangers of rise of temperature, severe pains, nephritis, urticaria, &c. The rises of temperature are to be particularly feared after an injection of gelatine in tubercular patients, so that its use must be limited to cases completely free from fever, in which other measures have failed to check severe hæmorrhage. Merck, of Darmstadt, supplies carefully sterilized gelatine in closed glass vessels; 40 c.c. of a 10 per cent. solution of this are heated to 107° F., and injected with a sterile syringe deeply into the upper part of the thigh, the buttock, or into the subcutaneous tissue of the axilla. The intravenous injection of 100 c.c. of a 2 per cent. solution, and the rectal administration of a saline gelatine enema (75 gr. of gelatine in two pints of physiological salt solution at 104° to 120° F. several times a day) have also been recommended. We wish to issue a most emphatic warning against the intravenous injection, the preparation for which is no longer made by Merck. Repeated injections of gelatine do not lead to sensitiveness.

For serious cases we prefer intravenous injections of saline solution, which have been recommended lately by van der Velden as a styptic. They have not failed us in a series of apparently hopeless cases. Sometimes, indeed, the improvement is only fugitive, since the coagulative effect passes off. Three to 5 c.c. of a 10 per cent. solution are injected into the vein of an arm. The solution can be easily prepared and sterilized as required. Subcutaneous injections of 200 c.c. of a 2 per cent. solution have also been recommended; their effect is rather less rapid. With these saline injections a rise of temperature of 2° to 3° F. can nearly always be observed. This fever is regular in its appearance and disappearance, is due to sympathetic irritation, and shows the importance of regulating the temperature of the fluid.

As a last resource for cases of profuse recurring hæmorrhage there is the formation of an artificial pneumothorax, providing that the site of the hæmorrhage is known with certainty, and that the state of the other lung permits the procedure.

We have no experience of the hæmostatic injection of the

serum of another animal, which has been recommended in France. The possibility of the occurrence of anaphylactic symptoms (albuminuria, urticaria, or subcutaneous hæmorrhages, &c.), especially if the injection of the foreign serum has to be repeated, makes this treatment unsuitable for tubercular hæmoptysis. Sterile horse serum for the purpose can be obtained. Lately the injection of human serum has been recommended; but the time does not seem to us to have come for its practical employment.

In cases of severe heart failure *digitales* and similar preparations are most useful; they have been recommended as hæmostatics in cases in which the colour of the blood and the nature of the bleeding indicate its venous origin. But this distinction is not usually possible. Focke has lately advanced the view that the spontaneous hæmorrhage of pulmonary tuberculosis arises in the great majority of cases (somewhere about nine cases out of ten) from the mucous membrane of the larger bronchi, in consequence of circulatory obstruction causing venous and capillary stasis; whilst bleeding from the tearing of a large vessel or an aneurism is more rare. We are far from believing that a tear of the vessel wall can be the cause of all pulmonary hæmorrhage; but pathological anatomy shows that it is so in all profuse bleedings. The great frequency of bleeding in the ulcerative forms of phthisis, no matter whether the process is in an early or late stage, is against the view that a circulatory congestion is a frequent, almost constant, cause. We consider, however, that a passive congestion of the deeper lung tissues may account for certain repeated small hæmorrhages, associated with heart weakness and a falling blood-pressure. Then *digitales* preparations may be indicated, in combination with regulation of the stools, careful deep breathing, and small doses of alcohol. We prefer *digalen* (15 to 20 drops *t.i.d.*, or 15 minims subcutaneously), Focke's infusion of *digitalis*, dialysed *digitalis*, and *digipuratum*.

We have not dared to employ the heroic remedy of emetics for pulmonary hæmorrhage; they have been warmly recommended by Stricker.

Inhalations of chloride of iron and surgical interference are to be avoided; blisters and mustard plasters are useless. Blood-letting, which increases coagulation by thickening the blood, is only to be considered when the blood is markedly overloaded with carbonic acid.

According to the severity of the bleeding, and the general condition, the patient must be kept in bed at least three days, and preferably from five to ten, after the blood has completely disappeared from the sputum.

For the removal of clots from the air passages expectorants and packs may be used after the hemorrhage has ceased for several days. To assist recovery from the consequent anemia iron and blood preparations (lactate of iron, *lug. ferri albuminai*, ferrucose, iron-squalose, iron-strupon, lecithin, &c.) may be ordered.

Breathlessness. During the course of pulmonary tuberculosis breathlessness develops but slowly and imperceptibly. In advanced disease the demands on the lungs become less, so that the still sound lung areas are able to maintain compensation. Therefore in uncomplicated phthisis breathlessness does not usually require special treatment. The rest that is ordered often suffices by limiting the need of oxygen. Temporary relief may be given by inhalation of oxygen mixed with air in a special mask, by small doses of alcohol, by heart tonics, and by oxycamphor (7 gr. *tal.s.*) and oxaphor (40 minims in water *tal.s.* before food), which are recommended by Jacobson and Cornet. This treatment is evidently directed towards an artificial stimulation of the heart, not to the state of the lungs; and it must be remembered that an overworked heart should not be treated for long with a whip. We hold that it is better to spare the heart, and, if there is great breathlessness, to use narcotics, probably morphin.

If sudden and severe breathlessness comes on during the course of phthisis it is usually due to an extension of the disease (miliary tuberculosis of the lungs, or general miliary tuberculosis), or to some tubercular or non-tubercular complications, such as pleural effusion, pneumothorax, aspiration pneumonia, bronchopneumonia, nervous asthma, and heart weakness. We need not here enter into details. The exact cause of the breathlessness must be discovered in each case, and the correct treatment applied.

Sleeplessness. Sleeplessness is no rare symptom in all stages of pulmonary tuberculosis. It is more common in women than men, in the upper classes than with poorer people. If it is affecting the patient bodily or mentally it is important that it should be removed. For this it is necessary to ascertain whether it is due to certain symptoms, such as cough, pain, perspiration, &c., or whether it has a nervous, neurosiphic, or toxic origin; for on this the treatment will depend. Of first importance is the general treatment by diet and hygiene, especially fresh air day and night, the afternoon nap, mental rest in the evening, early supper, and a regulated diet. A walk may be taken in place of the evening rest. Lukewarm baths, carbonic acid baths, chest-packs, and the use of the constant current (4 to 1

milliamperes) to the forehead and nape of the neck (Corney) are useful. We have often used the carbonic acid baths, which are given in the morning and not in the evening, and are to be followed by an hour's rest, but not sleep.

Frequently drugs must be employed. If there are no prominent symptoms infusion of valerian may first be tried, which is better than the tincture; then the bromine preparations, especially a mixture of the sodium, potassium, and ammonium bromides, or an effervescent bromide mixture, bromural tablets, veronal, sodium veronal, or adalin. One should begin with 4 gr. of veronal or sodium veronal in a hot liquid, and if it loses its effect increase to 7½ gr. Other preparations, such as dormol (2 to 5 capsules), sulphonal (15 gr.), stonal (15 gr.), are not required. Dionin and pantopen are only to be used if the sleeplessness is due to cough; morphia only in the very last stages. We advise that the hypnotic should be given for at least three evenings in succession, even when the first dose has already acted. If they have to be given for some time the preparation should be changed at intervals.

Digestive Disturbances.

As tuberculosis of the abdominal organs is separately considered, we may limit ourselves here to functional disturbances of digestion. They are very important; according to the figures of Jankowski and H. Strauss at least a third of early cases of pulmonary tuberculosis suffer from gastric and intestinal dyspepsia. Besides the true dyspepsias there are also those suffering from pseudo-dyspepsia, without anatomical or functional changes. The fact that some cases of phthisis belong to families of bad eaters is important.

Dyspepsia and the feeding of the patient are so very important in the course of tuberculosis, that their management is the first, and not the least weighty, part of the treatment of individual cases.

The loss of appetite, which often amounts to an aversion from food, frequently comes in early cases from unfavourable hygienic surroundings; in more serious cases it is part of the disturbance of all the functions caused by fever. In the latter case we are unfortunately often quite helpless. The appetite cannot improve on account of the severe disease, and this cannot improve on account of the insufficient nourishment.

The loss of appetite of early cases is generally to be overcome by an easily digestible and mixed diet, the different dishes of which must be both appetizing and varied. In this way the food will assist the effects of the open-air cure, the exercises, and the

hardening and bracing treatment. The cold meat treatment of Deboveiler, in which hot dishes are supplemented with cold, deserves consideration. Good cooking permits the combination of albuminous liquids and meat extracts with a slight amount of alcohol, and the addition of Madeira or other wine to strong meat broths, ox-tail soup, sauces, &c.

In obstinate cases a change of residence or climate may be considered. Hydro-therapeutic measures, such as complete and partial frictions, or compresses to the abdomen, may be tried; as may also stomachics and bitters (tinct. cinchon. 10., hydrochloric acid, tinct. rhai, strychnine, orexin, acid pepsin in mixture or tablets, thiochol, and strolin).

In irritable states of the stomach with hyperæsthesia, feeling of pressure, pain, hyper-acidity, pyrosis, and vomiting, all strong and spiced food must be avoided, and thick soup, gruel, stewed meat in small quantities, and especially milk, with or without lime-water, which also serves to neutralize the hyper-acidity, may be ordered. A particularly useful drug is bismuth in 100 small doses (5ss t.i.d.s. before food), or in combination with extract of belladonna (bismuth subnit. 15 to 30 gr., ext. bellad. $\frac{1}{2}$ gr., in pulv., one three times a day before food in water).

For superacidity and pyrosis sod. bicarb. or mag. carb. or a combination of both, may be used before food. Creosote preparations are often very useful, especially for heartburn.

For distension and flatulence, besides antacids, menthol (1 gr. in pill) or carbonate of guaiacol may be given.

For nervous hyperæsthesia, if bismuth and sod. bicarb. alone do not succeed, codeine may be added, or an opium suppository ordered. The carbohydrates must be diminished, the clothes must be loosened after meals, and no corsets worn.

If retching and vomiting are present it must be considered whether they are due to the cough, to hyperæsthesia of the pharynx, or to a general state of reflex irritability. In different cases diamin, codeine, or morphia, throat lozenges or bromine preparations may be indicated. Very useful also are orexin tonicum (4 gr. an hour before food), chloral-hydrate, the combination of tincture of iodine and chloroform recommended by Corne (5 drops of an equal mixture of both in water during meal-times), or validal (10 to 20 drops).

In cases of very obstinate dyspepsia we may follow Penzold's advice and wash out the stomach. It must only be done in cases in which the pulmonary disease is not very far advanced.

In conditions of diminished acidity, or in cases of achylia, which latter are very rare, the meat food and fats must

be cut down. A fluid or vegetable diet should be ordered, to which may be added soluble albuminous powders (enkasen and nutrose), which are both tasteless and odourless, contain 86 to 90 per cent. of albumen, and about thirty calories in a teaspoonful. Also bitters, hydrochloric acid, and pepsin are to be given, either in a mixture or in tablets.

The chief aim in treating all dyspeptic cases is so to alter the diet that in spite of the change there should be no diminution in the amount of nourishment taken. Whether this is always possible is another thing, but it must be always attempted by every means at our disposal.

In cases of intestinal indigestion and diarrhoea coarse food of every kind must be cut off; thick soup, rice, soft liquid foods, and especially good butter may be given. Astringent drugs may be required.

The constipation of consumptives must be treated by diet. Massage of the lower abdomen, followed by a short cold sitz-bath, enemata, and mild laxatives are all useful.

Diabetes Mellitus.

Whilst diabetes very seldom develops during the course of pulmonary tuberculosis, the latter is a very common complication of a previously existing diabetes. The frequency with which diabetes is complicated with pulmonary tuberculosis varies, according to the social status of the patient, from 5 to 50 per cent., the latter figure being obtained from statistics drawn from the poorer diabetes. Raw observed sixty-two cases of diabetes for periods up to 12 years, twenty-five cases were examined post mortem, and in all 32 or 52 per cent. were tubercular! This frequency must mean that diabetes produces a toxic predisposition to tuberculosis.

Pathologically the pulmonary tuberculosis of diabetes is characterized by having no predilection for the apex, but being localized in any part of the lung, not uncommonly in the lower lobe. There is usually extensive caseation and breaking down, without the least tendency towards connective tissue formation. The presence of sugar in the tissues affords a more favourable condition for the development of the tubercle bacilli and of the other organisms of a mixed infection. According to Raw the addition of diabetic blood to a culture medium encourages a luxuriant growth of tubercle bacilli.

Clinically there is a remarkably quick loss of weight, and in cases of very rapid phthisis a diminution of the amount of sugar in the urine. The fever is often moderate, in spite of mixed infection. Sweats are absent, on account of the desiccation of

the tissues. The diagnosis is not difficult, but one must make it a duty to examine the urine in all cases of alteration of nutrition. The course of pulmonary tuberculosis in diabetes is always unfavourable, and with bad conditions of life usually very rapid.

The treatment of tubercular diabetics is largely a question of diet, in arranging which the elimination of the sugar from the urine, under all circumstances, should not be our only object. Milk must not be entirely excluded from the dietary. The ingestion of carbo-hydrates must be kept within the limits of tolerance. Those articles of diet are to be considered the most suitable which contain the maximal amount of albumen in proportion to the carbo-hydrate. The amount necessary for nutrition must be made up by an increase of the easily digestible forms of fat, especially good butter. The duration of the rest cure must be restricted, but the exercise must be broken up by frequent short pauses for rest. Of drugs the opium preparations take the first place.

Obesity.

The combination of pulmonary tuberculosis and obesity is not so very rare, though generally phthisis is characterized by a disappearance of the subcutaneous fat. Tuberculosis is accompanied by obesity in chlorotic and alcoholic subjects. Or it may be a consequence of prolonged super-alimentation of the tubercular patient with large quantities of albumen, fat, and carbo-hydrate, which, owing to the diminution of the assimilative powers, produce a secondary obesity. Not uncommonly alimentary glycosuria or diabetes is present at the same time. Clinically, the combination produces dyspnoea on exertion, sweating, increased expectoration, and cyanosis. The fatty infiltration of the skeletal muscles causes weakness and languor, the fatty degeneration of the heart cardiac failure. The latter will be the more prominent the greater are the demands made on the heart by the pulmonary disease.

Obesity makes the prognosis worse; the lung disease usually follows a rapid course. Heart failure and pneumonic complications may be fatal.

The treatment is limited to the adiposity of stationary phthisical cases, since with progressive disease the fatty tissue disappears in any case. But even in stationary cases the rational cures for adiposity of Banting, Ebstein, and Orteil can only quite exceptionally be employed. We may, first of all, without a rigid diet, by diminishing the fats, carbo-hydrates, and fattening fluids, and by limiting the albuminous foods, attempt to bring about a weekly reduction of weight from two to, at the most, four pounds. A regular control by means of the weighing machine

and of urinary analysis is essential. Rest and sleep must be limited, and the amount of bodily exercise regulated by the capacity of the heart. So-called work (terrain) cures are only suitable for quite early cases, and must be very carefully regulated; the patient must not be allowed to sweat, which he does very readily, and which frequently causes chills on account of the bad cutaneous circulation. Massage and prolonged exposure to pure ozone-containing air increase the oxidation processes; the energetic tissue changes produced by high altitudes are particularly advantageous to these patients; they lose weight and gain strength. Vapour baths are contra-indicated, so too is usually thyroid treatment. A course of mineral water, especially at Kissingen and Homburg, is serviceable. The severe treatment of Moritz, which consists of taking fourteen pints of milk, without other solid or liquid, for five to seven days, makes demands on the capacity of the heart, which corpulent tubercular patients can rarely stand. On the other hand, one day of milk diet a week, on which two to three pints of milk is the only food taken, and as much bodily rest as possible is enjoined, is a useful method, free from danger, of diminishing the fat of tubercular people.

Gout.

According to Elslein, gout and tuberculosis are not uncommonly associated; but current medical opinion is in agreement with Minkowsky, who finds that the two diseases are seldom combined, though they do not exclude each other. Raw found in fifty-seven cases of gout (with eleven autopsies) in no single instance even a trace of tuberculosis; so that he considers gout to be directly antagonistic to tuberculosis. The recognized antithesis between the tubercular and gouty disposition is considered to be the reason for this. This is correct, since the constitutional form of gout, in contradistinction to the so-called acquired form, is associated with a build and state of nutrition which is unfavourable for the development of tuberculosis. But experimental and clinical observations do not show that an increase in the uric acid contents of the blood is a protection against tuberculosis. The therapeutic feeding on raw meat, meat juice, or nuclein is not, therefore, to be justified on these grounds. The observations of Raw must be taken into account, however, who only obtained a scanty growth of tubercle bacilli on media to which blood from gouty persons had been added.

Pathologically the tubercular processes in the lungs of gouty persons are marked by a great amount of connective tissue contraction. In advanced tubercular disease the likelihood of the occurrence of attacks of acute gout is diminished, on account of

the weakening of the whole body. From the point of view of diagnosis it may be noted that a hæmoptysis in a gouty patient may be due to a non-tubercular congestion of the lung.

The prognosis is good. The course of treatment must follow the middle path between the measures suitable for tuberculosis and for gout. Alcohol should be entirely excluded from the diet, meat and fats in every form may be allowed, green vegetables and raw fruit should be recommended, and the carbo-hydrates diminished. The mineral water of Vichy or Neuenahr may be drunk, or the warm baths of Wildbad, Wiesbaden, or Baden-Baden employed, according to whether tuberculosis or gout predominates.

Syphilis.

Syphilis plays no small part in the ætiology of tuberculosis. Constitutional venereal disease and its specific treatment weaken the organism often to such a degree that phthisis may easily be contracted, or an old tuberculosis may be transformed into an obvious or acute form. Also the progress of phthisis is usually very unfavourably influenced by an already existing syphilitic infection, if the latter is still in a recent active stage. In cases in which the first symptoms of pulmonary tuberculosis appear soon after a syphilitic infection, it frequently develops into a rapid florid phthisis. The tubercular disease spreads over various lobes of both lungs, with high fever and marked blood changes. Without there being much dulness there are extensive catarrhal and destructive processes; the larynx or intestine becomes infected, and in spite of the diminution of the syphilitic symptoms, either spontaneously, or under prompt treatment, a fatal issue occurs in several months, or in any case extremely rapidly. One sees in such cases that the recent syphilitic virus has undermined all the natural defences of the body against tuberculosis.

If the venereal disease is already in the third stage when the tubercular infection gains an entry, the course of the tuberculosis is not unfavourably influenced. French authors even think the prognosis is favourable if the syphilitic virus has exhausted itself (Bernheim), and the tuberculosis takes on a more fibroid character (Mansueti). The latter is true in so far as the pathological changes due to the venereal disease may encase the tubercular foci, and so prevent their extension.

The second possibility is that during the course of pulmonary tuberculosis syphilis may be contracted. Old chronic forms of tuberculosis are usually not made worse, while recent disease, which is inclined to progress, is generally spurred on. Also the syphilitic symptoms, according to Fournier, are more severe in

the presence of tuberculosis. But there is also an idea that syphilis, contracted by a phthisical patient, runs a mild course in consequence of an antagonism between the syphilitic and tubercular poisons. Loebte limits this by saying that it is only in febrile phthisical patients that the syphilitic symptoms are slight or do not appear.

Lastly, there is a form of double infection by syphilis and tuberculosis, in which both diseases occur at the same time in lungs or larynx, and reciprocally affect each other. Such cases are found at autopsies, but are rare and very difficult to recognize clinically; their course is very variable.

In the treatment of the combination of syphilis and tuberculosis the general measures of hygiene and diet are indispensable. How much may be done, beyond the general measures of treatment directed principally against the tuberculosis, in the form of specific anti-syphilitic treatment, depends on the grade of the pulmonary disease. In regard to mercurial treatment the following indications are generally recognized: Far advanced, cachectic phthisical cases with high fever must be excluded altogether from mercurial treatment, which would only hasten the end. In all other cases it can and must be tried, the dose of mercury being carefully regulated. The inunction method, which with intervals of rest may even be used for borderland cases, serves to prepare the way for the subcutaneous or internal administration of mercury; the latter must not be used without preliminaries. For strong, afebrile cases we have employed the usual inunction cure (ungt. hydrag. cin. 30 to 60 gr. a day) combined with short radiant baths to induce perspiration, and have thereby obtained an improvement also in the lung condition and in the number of bacilli in the sputum. When the inunction method cannot be continued we give mercural (Riedel) internally (two capsules three to four times a day).

Iodine preparations we do not employ. Whether there can in large doses, such as are required for the treatment of syphilis, produce hæmorrhages, may be left on one side. Even when given as sodium iodide they affect the appetite unfavourably, cause general perspirations and frequently have no good effect on the combination of syphilis and tuberculosis. Large injections of iodipin we cannot recommend, as we have seen abscess formation in the buttock with their use, in spite of the most careful asepsis.

As there can be no more doubt that Ehrlich's salvarsan is a specific means of cure for syphilis, its use seems to be indicated also for syphilitic phthisical cases. We are guided by the consideration that on the one hand the arsenic preparation cures

syphilis surprisingly rapidly, and so prevents the bad influence syphilis and tuberculosis have on each other, and on the other hand mercurial treatment may accelerate the phthisis. In the Virchow Hospital, in Berlin, phthisical patients have received salvarsan injections, not only without bad effects, but with a regular alleviation of the symptoms and an improvement in the body-weight. Weber especially recommends salvarsan for those cases of syphilis which are complicated by tuberculosis. R. Hoffmann observed in a patient with a positive Wassermann reaction, who was suffering from advanced open tuberculosis, with extensive tubercular complications in the pharynx and larynx, that after an injection of salvarsan all the granulations and ulcerations disappeared; possibly they were of a syphilitic nature. Also Treupel and Levi have found in a large number of cases, that syphilitics, who also suffered from an open tuberculosis, after a salvarsan injection had no bad lung symptoms. Only one patient, who had old apical distress, developed a febrile pleural effusion, some three weeks after the intra-muscular injection, and it is quite possible that in this case a latent tuberculosis was rendered active. Severe non-tubercular, purulent catarrh and marked heart weakness are contra-indications. As arsenical preparations improve the nutrition of consumptives, sometimes with the best results, one would expect salvarsan to have a favourable, rather than an unfavourable, effect on pulmonary tuberculosis.

Alcoholism.

Since one author considers the regular consumption of a glass of beer or wine as alcoholism, while another will include under that head nothing short of habitual, daily drunkenness, all statistics as to the casual connection of alcoholism and consumption have only a relative value; and we have no need of such statistics. We know that the alcoholic person is a diseased person; that alcohol is a muscle and nerve poison, to which people are susceptible in a varying degree; and that habitual and frequent drinking, even if the amount of alcohol is not excessive, in every case will lead sooner or later to a deterioration of nearly all the tissues and organs, and a lowering of the resistance of the body. This may either increase the liability to a tubercular infection, or may give an impetus to a more rapid spread of an already existing disease, and diminish the chances of healing. We need not go into details; the dangers and evil consequences of alcoholism in favouring the development of the many complications of tuberculosis are a matter of everyday observation.

There is a question what part alcohol should play in the

treatment of tuberculosis. Large doses of alcohol (Mirreos ordered 3 pints of wine a day) have been given to consumptives, with the idea that such quantities favoured the growth of connective tissue and the cicatrization of the diseased areas of the lungs. It has also been stated that large quantities of alcohol increase the powers of the organism to neutralize the tubercular toxin, and raise the antitoxic value of the serum. We must refuse to accept such results founded on isolated *postmortem* evidences. It is also certain that the assertion of the total abstainers is not correct, that pulmonary tuberculosis may be due to alcoholism alone, and that with the cessation of the alcoholic abuse the lung disease will disappear of itself. But in individual cases, in which alcohol and tuberculosis are working together to damage the lungs, our first care must be to cut out entirely the alcoholic factors. Alcoholics, and patients intolerant of alcohol, must be compelled to abstinence. We recommend a gradual reduction, since undoubted cases of delirium have occurred in consumptives from sudden cessation of alcohol. After the reduction alcohol must not be used as a drug, either internally or externally, and the patient must be induced to become a total abstainer.

We consider it important that the alcoholic consumptive, when he is not amenable to the restraints of abstinence, should be cut off from the benefits of sanatorium treatment for the good of the community. Such patients receive scarcely any benefit from the sanatorium treatment, they lead other inmates astray to the public-houses, and induce in those unaccustomed to alcohol a habit which may persist after the discharge from the sanatorium and may considerably aggravate the disease. There have lately been efforts to make all inmates of public sanatoriums abstainers by the exclusion of all alcoholic drinks; it is hoped that a large number may remain abstainers after leaving the institution, and that the money so saved may help to improve their conditions of life. The pros and cons of this question, and the relative merits of abstinence and temperance, we may leave to the individual judgment.

X. Treatment in Sanatoriums, Health Resorts, and Hospitals.

We have intentionally first considered all the methods of cure that we have at our disposal for the treatment of pulmonary tuberculosis, one after another in sections complete in themselves. We have tried to avoid throughout taking a one-sided standpoint,

and everything which might seem to indicate personal interest in any one method, or prejudice against others. We wish, further, to leave it to the judgment of every conscientious doctor to choose, out of the many weapons we possess, those which he considers possible, suitable and necessary for the treatment of each individual patient. In that consists the whole art of medicine as applied to the treatment of pulmonary tuberculosis. It is a matter of indifference whether the doctor is connected with a sanatorium, hospital or health resort, or whether he is in general practice. No preconceived opinion, no dictum of authority, and no personal interest must blind us to the paramount interests of the patient.

It might be thought that these considerations might be taken for granted, and that the foregoing were merely superfluous words. But it is not so. Pulmonary tuberculosis is a ubiquitous disease; every doctor is brought into contact with it every day. There is a feeling that, according to vested interests, this or the other method of treatment is put forward as the best and only right way of dealing with tuberculosis, and that on the other hand private practitioners can hardly be expected to rob themselves of their *chicotele*, so that it is high time to speak plainly.

We will therefore put into the foreground of the following sections on the treatment of pulmonary tuberculosis in sanatoriums, hospitals and health resorts, the general point of view. A section on home treatment, which must naturally form the commencement and end of the treatment of every case of phthisis, concludes the whole.

Sanatorium Treatment.

Sanatorium treatment may be carried out in public or private institutions. The former have been constructed in consequence of the good results obtained in private sanatoriums, and from a general feeling that a similar treatment should be practicable for the less wealthy classes. The public institutions have been built perhaps with less regard to comfort, but not less to hygiene; they provide, it is true, a more simple nourishment, but one entirely adequate in quantity and quality. In both the treatment is founded on the general lines of hygiene and dietetics laid down by Brehmer and Dettweiler. The difference, therefore, is in no way fundamental, but is purely one of expense. The private sanatorium does not offer more in the way of chances of cure to the wealthy for eight to twelve shillings a day, than the public one does to the less wealthy for three to four shillings. We consider the private institutions separately for the sake of con-

venience, but both represent the same principle, namely, the treatment of pulmonary tuberculosis in an enclosed institution.

Pengoldt considers that a well appointed and directed sanatorium should have the following advantages: A favourable position in its own grounds, in the neighbourhood of hills and woods, well exposed to the air, but sheltered from the winds. In the construction proper regard must be paid to hygiene in the matter of the positions of the rooms, ventilation, heating, &c. Proper provision must be made for lying in the open air by means of shelters, verandas, balconies, &c. Absolute cleanliness, especially in dealing with the expectoration, good cooking and a good milk supply are all essential. The institution must be conducted by an energetic doctor, who has had a good general experience, but who is also a specialist in tubercular diseases; he must have absolute authority over the patients; there must be a sufficiency of trained assistant doctors, and a good staff of servants. The patients must be completely cut off from their domestic affairs, and friendly intercourse and permissible diversions must be encouraged; all excesses on their part must be impossible, and they are to be excluded as far as possible from the contagion of intercurrent maladies.

We fully agree with these remarks, and, for our part, would refuse the name sanatorium to any institution in which the construction or management did not comply with these requisites; they should be more correctly termed boarding houses or convalescent homes.

What cases of pulmonary tuberculosis are suitable for sanatorial treatment? In deciding this question it is not sufficient merely to consider the grade of the disease, because this classification is based upon the state of the lung alone, which is not the only important factor. It may be said in general that initial pulmonary tuberculosis, as long as it is not accompanied by persistent fever, or by severe tubercular or non-tubercular affections, is suitable for institutional treatment; and that the last clinical stage, with more or less high fever, is unsuitable. There are no difficulties, or at least there should be none, in recognizing cases of either extreme as suitable or unsuitable for sanatoriums.

Cases on the border-line, which may be either still suitable or no longer so, cause more difficulty; the temperature in such cases is of the greatest importance. If the mouth temperature, taken regularly every two or three hours for several days in succession, never exceeds 99.6° F., it can be inferred that there is no swiftly advancing disease. It is important also to know if

the lung trouble is only slowly spreading in spite of unfavourable conditions and continual work, or if it is making rapid progress though the surroundings and mode of life of the patient are favourable. The importance of the character, disposition, age, and hereditary tendencies of the patient must not be underestimated. It is an established fact that phlegmatic consumptives reap a quicker benefit from sanatorium life than excitable, highly-strung, nervous natures; and that middle-aged or elderly people make a better and more lasting cure than the young. An inherited tendency makes the prospect worse, when it shows itself in defective bodily development. If the associated conditions are favourable, that is if the patient has a strong general constitution with a well-developed chest and sound heart muscle, and if the general bodily and mental health is not much lowered, then there are still good prospects from treatment in an institution, even though the case is on the border-line, and large areas of the lungs are diseased. But these cases certainly must not be complicated by tuberculosis of other organs, or by other illnesses, as diabetes and inflammation of the kidneys.

The selection of patients for sanatorium treatment is necessary, not in order to obtain good statistical results, but in the interest both of the slight and the severe cases themselves. The institution is provided with a domestic staff for average cases; it cannot attend to more than 10 per cent., now 30 per cent. of patients confined to bed, as such severe cases must be. If, too, hopeless cases are congregated in a sanatorium, so that deaths are frequent, it has a most depressing effect on all the other patients. Since sanatoriums can be of no real service in hopeless cases, and must consider the good of the majority, they must insist that the cases they receive have fair prospects of recovery, or at least of improvement. We may pass over other reasons.

An important practical point is whether cases may be admitted into sanatoriums for prophylactic reasons. We do not consider that there is much danger of infection in a well-appointed and well-directed institution, but we answer the question decidedly in the negative, for the principal reason that anyone disposed to tuberculosis should not be introduced into the company of those already tubercular.

For the same reason we consider the admittance of non-tubercular lung cases into sanatoriums for consumptives as altogether contra-indicated. The differential diagnosis may not always be possible in general practice, but it is the first and most important duty of those in charge of institutions to verify the diagnosis, and to send away the non-tubercular. The exclusion

of both prophylactic and non-tubercular cases from institutional treatment is not only to be observed amongst patients sent at the cost of industrial insurance, clubs, unions, &c., but also for all cases, even in private sanatoriums.

What results are obtained by the sanatorium treatment of pulmonary tuberculosis? Whether good results are obtained by public sanatoriums has been disputed, while the success of private institutions is usually recognized. This can be accounted for by the fact that patients stay considerably longer in private institutions, and that after discharge the conditions of life are more conducive to their keeping in health. We must bear in mind that the length of stay in public sanatoriums is on the average ten to thirteen weeks, and that, after leaving, the patients, almost without exception, are obliged to return to very harmful surroundings, some of which they can help, some they cannot. The results, therefore, appear quite good, considering also that only one-third are admitted in the first stage of the disease, while one-third are in the third stage. Collection of a large number of statistics gives the following results: (1) The immediate result of sanatorium treatment was that 88 per cent. were capable of work; (2) the result after five years was that 42 to 43 per cent. were still able to work; (3) the number of deaths during the five years was 20 per cent. These figures, like all others, may be objected to; they have the advantage of being based on large numbers.

Further, at least 20 per cent. of the patients, who came to the sanatorium expectorating tubercle bacilli, lost the bacilli under treatment. Cornet disputes this; while the opinion of F. Kraus is that the extent to which bacilli disappear in sanatoriums is "no less than surprising."

But the sharp criticisms passed by Cornet, Grotjahn, and others on the sanatorium results have done good. It has compelled sanatorium doctors to make more efforts to improve their results, especially in open cases of pulmonary tuberculosis, by reconstructing their system. According to our ideas this could only have been brought about by tuberculin treatment; and we were right, it has been brought about.

We will only use statistics dealing with large numbers. According to Curschmann, after a three months' residential sanatorium and tuberculin treatment in the Baden Insurance Institution, 80 per cent. of the patients with open pulmonary tuberculosis in the first stage, 47.7 per cent. of those in the second, and even 33.75 per cent. of those in the third, became free of bacilli. Löwenstein reports from the Berlin Insurance Sanatorium that out

of 682 patients, at the end of the tuberculin treatment, 361 = 52.93 per cent. had no longer bacilli. We ourselves have ascertained that of 390 cases of open tuberculosis treated for a long time in a sanatorium with tuberculin, 100 per cent. of cases in stage one, 87.3 per cent. in stage two, and 44.2 per cent. in stage three lost both bacilli and sputum by the end of treatment. The conclusion to be drawn is that the combination of general hygienic treatment with the use of tuberculin is very effective, and far exceeds the results of either method employed singly. We can therefore understand why tuberculin, which was employed in only 30 per cent. of the sanatoriums in 1907, was used in 75 per cent. in 1911; and, according to the latest inquiries of Muiray, as many as 61 per cent. of the public sanatoriums now systematically employ the specific treatment in order to obtain more lasting results in a shorter time. The most experienced practitioners in the high mountain resorts also do not omit tuberculin from their armamentarium. They find that the combination of the three factors, sanatorium, climate, and tuberculin reduces the fever more rapidly and more permanently, and gives more satisfactory and lasting results in those moderately severe chronic cases of tuberculosis, which are refractory to the influences of the sanatorium, the climate, and the sun.

It cannot now be said by those antagonistic to sanatoriums that they do nothing but create "an endless number of discontented people." It appears to us that treatment in an institution is beneficial in three ways: (1) It ensures the exclusion of the harmful factors arising from the occupation and the home, and the persistent infection connected with the unhygienic mode of life in the widest sense, the removal of all which is so very important in dealing with many chronic diseases; (2) the general treatment strengthens the resisting powers of the system, increases the whole vital energy, and stimulates the failing powers by regulated rest and exercise; (3) it gives an opportunity at the same time for reaping the full benefit of any other approved treatment, such as the use of tuberculin.

If the facilities for the institutional treatment could be increased the progress of tuberculosis as a national disease would be checked.

To recapitulate, we consider that the combination of the tuberculin treatment with the general sanatorium treatment is to be strongly supported as the most successful method for all cases of pulmonary tuberculosis who have a chance of recovery. It is urged that it should be carried out for all still curable cases, which, without it, threaten to become worse or incurable.

**Private
Sanatoriums.**

For private patients, who pay their own expenses, matters are very simple. If the patient is prepared, in accord with medical advice, to undergo sanatorium treatment, it is easy to furnish him with a list of institutions which can be recommended. The choice will depend upon financial, personal, and local circumstances, and the wishes of the patient. Having obtained full details of the institution selected, the patient, or the doctor, ascertains if admission is possible. Some private sanatoriums require a full and detailed medical report; the majority are satisfied to learn in what stage the disease is, the state of the temperature, and whether complications are present or absent. Many institutions are satisfied with the statement that the practitioner considers the patient a suitable case. The patient should not start till he has heard that he can be received, and must not neglect to inform the sanatorium authorities of the time of his arrival. The most important point is that the patient should be introduced into the sanatorium at the earliest possible stage of the disease. Although private sanatoriums need not be as strict as public ones as to the cases they receive, yet they have a right to expect that practitioners should not send them hopeless or terminal cases. Patients should be advised by their doctor as to the arrangements for the journey, stopping the night *en route*, &c.

**German
Insurance
Scheme.**

In Germany, for those who are insured by the State insurance scheme, and for their widows—but not for their wives—the cost of the sanatorium treatment is undertaken by the insurance societies, pension funds, and State-sanctioned societies. The insured has no legal claim on these benefits. To attain as far as possible a uniform procedure it is enacted that the sanatorium treatment is only allowable: (1) If a near approach of invalidity (prolonged restriction of more than two-thirds of the capacity to earn a living) is to be feared without such treatment; (2) if there is a certainty, or a probability bordering on a certainty, that by means of such treatment the approach of invalidity will be prevented for a succession of at least two to three years. For instance, the mere need of strengthening the patient can never justify the ordering of the treatment. There must be expected to result from the treatment, either a definite prolongation of the present capacity for work, or a shaking off of the existing incapacity, which is to last several years. The aim of the scheme is to avert premature invalidity; so that what is spent on the cure may be recovered from the revenue. If these suppositions cannot be justified the doctor may not recommend the cure at the expense

of the insurance society. It is therefore evident how enormously important is the early diagnosis of pulmonary tuberculosis among the working classes.

Health Resorts.

In the sections on climatic treatment and balneotherapy we have already stated our opinion that the cure of pulmonary tuberculosis is not to be expected from climate or medicinal waters alone. On the other hand the effects of these factors on certain cases of phthisis cannot be disputed, so that they may often be used to support other methods of treatment. Care must be taken that the benefits are not counterbalanced by dark and sunless rooms, by swallowing the sputum through fear of using the sputum flask, by excesses of alcohol or gambling, by love making, or by insufficiency of medical treatment and guidance. Also in health resorts precautions must be taken against the tubercular patients indulging in excess of sport of any kind. The doctors, of course, cannot keep the patients away from every harmful form of distraction, as is possible in a sanatorium, but they must always do all in their power towards this. They are more likely to succeed if they give the patient printed directions for the treatment, and fill up the day with suitable divisions of exercise and rest, the latter in the open-air. We are glad to be able to say that this is becoming more and more possible in the resorts for lung cases. By adding the tuberculin treatment to the climatic, it becomes more potent and individualized. There is no fear that on this account the health resorts will lose their reputation; the one form of treatment does not exclude the other. We are entirely in accord with Wolff-Eisner, who warmly recommends, both for open and closed forms of tuberculosis, the climatic treatment, combined with tuberculin. We also hope that the doctors practising in the resorts for lung cases will see that by adding tuberculin to their treatment they will enhance the reputation of their resorts.

"To make a correct choice of a health resort is an art" (Kraus). The state of the lungs must not only be taken into account, but also the general physical and mental constitution of the patient, his character, inclination, idiosyncrasy to climates, financial means, the time he can give to the cure, and the presence or absence of other complications. The doctor also should have knowledge of the health resort to which he sends his patient, with its facilities for treatment, its means of housing, the outlay demanded, and the medical colleagues practising there. He is safest if he first sends his patient to a sanatorium in the health resort; of which there are a considerable number. If after a

longer or shorter period of observation it is found that the patient would be better at another place or at home the change must be made by the sanatorium doctor.

The indications and contra-indications for the climatic health resorts and watering-places have been given earlier, but there are still a few general directions. There are patients who have a violent, almost morbid, aversion to being secluded in a sanatorium. In such a place they become sleepless, nervous, and melancholy, lose all their appetite when they enter the common dining hall, grumble at everything, resist all treatment, see unjustifiable restraint in all beneficial rules, and, in fact, give a display of behaviour which betrays complete loss of mental equilibrium. For such patients treatment in a health resort, outside institutions, is suitable. So also is it for slight cases, which have already undergone sanatorium treatment; also for chronic cases which have remained stationary for years, and for cured patients, who by means of such a yearly holiday may maintain their health and strength. Prophylactic cases should not be sent to a sanatorium, nor to frank, or veiled, resorts for consumptives, but for a winter visit in some other mountain place. Lastly, climatic treatment can only be recommended to patients of a serious character, and of sufficient will-power to carry out the general constitutional treatment to the end, without perpetual medical control.

Patients who are beyond cure or hope of improvement must be discouraged by their doctor from making the journey. He must try and keep them back, must comfort them, and even deceive them. He will thus spare them the fatigue, and the inevitable disappointment; and their friends the often appalling expense which is apt to be incurred by death away from home.

Fever is not an absolute contra-indication for travelling, provided it is only moderate, not above 100.4° F. for example. More depends upon the general condition and strength, and the place to which the patient is to travel. To allow feverish patients to travel to a health resort without having first arranged for their reception is always very dangerous. We know that the temperature will rise still more with the journey, and that such patients are exposed to great risks of pneumonia, hæmorrhage, &c., if they have to drive about in a carriage looking for rooms. We cannot reckon, moreover, on the quick disappearance of the fever with the change of climate. It is possible that it may occur, but not with any regularity; high fever may not be at all diminished, or only after a long stay. The necessity of going to bed on his

arrival with high fever, which in spite of the climatic influences and a prolonged rest in bed may last for weeks, has a very depressing effect on the patient; the loneliness and isolation produce *home-sickness*; the thought that the health resort was not properly chosen arises, and that the expenditure of time and money is all in vain. It is therefore better in cases of considerable fever to wait, and to allow the patient to travel only when it has diminished; when he may be accompanied by some sensible person to some place where they are prepared to receive him. Feverish patients should be sent neither to a hotel nor a boarding-house, but to a sanatorium.

On the other hand we may have to insist on the journey if it is being constantly postponed by the patient without real cause, as is frequently done by married women for easily understandable reasons. The disease gets worse by waiting, and the curable case may become incurable; and then the doctor is frequently reproached with having recognized or disclosed the disease too late.

We agree with Cornet that difficult children are better treated at home, and that as a rule they are better in the charge of a reliable stranger than a relation. We also agree that it is better for a healthy young husband or wife not to accompany their sick wife or husband as a rule; but here it is necessary to be guided by circumstances, which are not the same in every case.

Hospital Treatment.

Whether hospitals were suitable or necessary for the treatment of pulmonary tuberculosis was for a long time disputed, but has now been decided in the affirmative by the Federal Government (for Germany). In order to make use of hospitals proper hygienic arrangements are the first necessary. It is desirable that they should afford the opportunity of effective isolation for prolonged periods of as many cases of advanced pulmonary and laryngeal tuberculosis as possible. Besides serving the purpose of isolation, which will be further considered under the section on prophylaxis, they are to be used, very rightly, also for treatment. For investigations made in the homes of incurable patients have shown that only if a simultaneous curative treatment is carried out is voluntary isolation to be obtained in any considerable degree.

It has been ordered, to attain these ends, that State hospitals are to be fitted with separate annexes, constructed according to sanatorium principles with open-air shelters, baths, douches, &c. In new hospitals attention must always be paid to the construction of such annexes for tuberculosis; in old ones in large towns with

unsuitable surroundings, a separate tuberculosis hospital is to be built in some healthy neighbourhood.

The question arises whether the therapeutics of tuberculosis, especially the open-air cure, can be properly carried out in hospitals and annexes. There can be no doubt that a tuberculosis hospital constructed *ad hoc*, in a healthy wooded district outside the town, may offer all that is required in the way of pure air, protection, &c. It only remains to secure a doctor experienced in tuberculosis treatment for the hospital to become a sanatorium and home for all stages of pulmonary tuberculosis. Whether an annex to an already existing hospital can be suitable is more debatable. It largely depends if the hospital has suitable grounds, in which pure air, quiet, &c., can be obtained: a condition that cannot be fulfilled in all industrial towns.

The cases suitable for the hospital treatment are:—

(1) Early cases, which are waiting, often for four to eight weeks, their turn for admission into a sanatorium. By this means they are at once removed from the harmful surroundings of their home.

(2) Cases temporarily insured to sanatoriums may remain in the tuberculosis hospital until improvement has progressed so far that sanatorium treatment is possible, which sometimes occurs in apparently unlikely cases.

(3) Advanced cases may remain in the hospital to the end, with great increase of comfort to the patient, and removal of the danger of infection of his home surroundings.

(4) Chronic cases, which at times are able to work, but which at other times, especially in the winter and autumn, are incapacitated by intercurrent catarrhs and other infections, may be received for six weeks or so at a time, with great benefit to the patient and prolongation of his capacity for work.

(5) Ambulant cases may come to the hospital as a centre for tuberculin treatment, after being discharged from the sanatorium or from the hospital itself. There can be no doubt that discharged patients at present may secure an improvement in their home conditions, food, and work, but that there is great difficulty in prolonging the tuberculin treatment. So much may be done in this way that this branch of the work of the tuberculosis hospital should become most important.

For this purpose there must be systematic co-operation of the hospital doctor with the sanatorium physician, and the general practitioners, especially with those engaged in working the insurance scheme.

It will thus be seen that there is a splendid programme of

work for the tuberculosis hospital, worthy to be carried out by the very best physicians.*

XI. Home Treatment.

In looking through the recent literature on tuberculosis, we are constantly meeting the idea that it is the duty of the practitioner to diagnose pulmonary tuberculosis in its early stage, and then hand the patient over for institutional treatment. We hear but little about the co-operation of the practitioner in that treatment; and about the difficulty of attaining the ideal laid down.

Scope of Home Treatment.

In practice weeks and months may pass between the recognition of the disease and the possibility of the patient being received in a sanatorium. During this time the patient must be treated by the practitioner. After three months' treatment in a sanatorium the patient turns up in the doctor's consulting room cured, or not yet cured; in any case continuation of the treatment is generally necessary. So it may go on for years, with now and then a relapse and at times a spell in bed. Sometimes another stay in the sanatorium may interrupt the attendance of the practitioner; otherwise the home treatment continues. Or else the patient may have come too late to the sanatorium; he returns home no better, and remains under his doctor's treatment until death. Other patients, for whom the benefits of the sanatorium are not available, may remain under the care of the practitioner from beginning to end.

Even if sanatoriums are provided for the poor and the rich, there is a great lack of provision for the middle classes; the public sanatoriums are continually full, and the private ones are mostly too expensive. On account of the expense, there is often a long wait to see if the first treatment of the doctor at home will be successful. If this fails a visit to a sanatorium or health resort is decided on, but usually cannot last long enough; questions of the means of existence, and the claims of the business or profession only too often bring the stay to a premature end, and further home treatment is necessary.

Even in circles where the question of expense does not enter, the inclination of the patient to leave home and spend several months in a sanatorium is not great. Many go to a winter or summer resort, and return home at the end of the season. The

* From this section have been omitted a list of sanatoriums, mostly all in Germany, and some of the details connected with the working of the German insurance regulations.

result is that the private practitioner or specialist is again visited; in either case home treatment must be resumed.

Considering all these facts, we see that the home treatment of pulmonary tuberculosis must take the first and most important place. Statistics show this also. The 12,180 sanatorium beds in Germany, with an average stay of three months a patient, can receive about 36,700 cases of pulmonary tuberculosis a year. Against this there are about 500,000 to 600,000 cases requiring treatment; so that about half a million demand home treatment. Figures also show that by far the greatest number of cases die in their own homes; in Prussia about 30,000 a year.

Enough has been said to show that the beginning and end of the treatment of phthisis must take place in the home. It is not altered in the least by the obligation, which rightly rests on the practitioner, of giving up the treatment of every case as soon as he has an impression that it could be carried out better elsewhere.

We now come to the most important practical question. Which are the cases of pulmonary tuberculosis for whom home treatment does not promise to give much result?

Difficulties of Home Treatment. In a broad sense the injurious effects of occupation can be avoided by cessation of work—but this usually means cessation of income also—so that the possibility of providing the necessary increased nourishment becomes an improbability. The open-air cure is practically impossible in a house in the middle of a town, perhaps in the factory quarter. In the summer the patient may be able to carry out the cure in woods around the town, but in winter it is scarcely possible. Hydrotherapeutic means may be employed, but the proper understanding of them is wanting; as is also that required for the maintenance of good personal hygiene, and the avoidance of harmful influences both to the patient and his healthy relatives. So that everything impels us to remove tubercular patients of the working classes from their unhygienic surroundings, and give them the chance of proper general treatment in an institution. Only when the patient has been instructed here, and has felt personally what is good for him, can the home surroundings be made the best of, and the system of home treatment, to be carried out to the end by the practitioner, be based on a sure foundation.

Even in families in a good position there are often difficulties in the way of home treatment. Firstly the patient is not sufficiently cut off from the business or occupation, especially so in the case of married women; even if bodily or other work is given

up there still remain excitement, worry, responsibility, social duties, &c., which interfere with complete rest. Some people while at home consider it a sign of foolishness and lack of energy to impose on themselves the necessary restrictions. A patient, too, will frequently swallow his sputum, from æsthetic consideration of others. In such cases the doctor will see that the home treatment had better be replaced by several months in an institution, during which the patients "all receive an education in self-treatment before they are thrown more on their own resources." (Penzoldt). So here again the lessons learnt in a sanatorium are necessary preliminaries to effective home treatment.

But what is to happen to nine-tenths of all the cases of phthisis, who for various reasons never enter a sanatorium? Is the practitioner to retain his former passive attitude to them, which has hardly given cheerful results?

General Home Treatment.

In the home treatment of phthisis general constitutional measures again form the foundation on which we must build. Therefore in the several sections of this chapter we have never insisted that the various necessary measures, especially open-air treatment, proper nourishment and hydrotherapy, can only be carried out in a sanatorium, since they can all to a certain extent be practised at home. From what we have seen in our own practice we can say that general home treatment, if limited to essentials, in most cases may with goodwill be carried out without special difficulties. When in exceptional cases all means are lacking, then help must be obtained from the poor law, dispensaries, convalescent homes, soup kitchens, &c. Here it is a case of where there's a will there's a way.

There is, spread over the whole of Germany, an organization for the fight against tuberculosis, which offers to neccessitous cases the possibilities of sufficient nourishment and the benefit of the important factors—light, air, and water. These measures will have to be adapted to the home treatment of tuberculosis. This has already been systematically done in many places by means of dispensaries and polyclinics for tubercular lung cases; and also by means of country homes, which have lately been built to provide nighty rest under healthy conditions.

Dispensaries.

It is particularly the dispensaries (*Fürsorgestellen*) which do so much good work in the fight against tuberculosis, because they assist the general practitioner in detecting the tubercular lesions, and in disinfecting and rendering as healthy as possible infected households. The dispensary doctors are not, as was at first feared, the competitors

of the club and poor law doctors, but rather aid them in making the diagnosis, in furnishing the necessary reports, and devising a line of treatment, which the private practitioner may carry out. The nurses, visiting the homes and families of the patient, assist both in treatment and prevention. Dwellings are put into the best sanitary condition possible, and maintained so; patients with bacillary sputum are put into separate beds, and if possible into separate rooms; wives are urged to manage their children on hygienic lines, to keep them clean, and to feed them as appropriately as possible; suspected relatives are examined for tuberculosis, and infected children removed to suitable institutions. The finances of the dispensary provide not only for beds, blankets, rent, disinfectants, sputum flasks, thermometers, but also for milk, invalid food, clothing, &c. All these measures considerably simplify the work of the practitioner, and the home treatment of tubercular patients in the poorer class of society. The following figures will show the range of work; for instance, under Pütter in Berlin, the founder of German dispensaries, during a period of two and a half years, 34,800 persons were examined for tuberculosis, 18,200 dwellings had their sanitation improved, and 1,600 children were sent to special homes. Every year about 1,000 patients with open pulmonary tuberculosis were isolated.

**Ambulant
Tuberculin
Treatment.**

In every clinically suitable case of tuberculosis the tuberculin treatment may be added to the general constitutional measures, whether the patient be rich or poor. In our experience there is no great difficulty in the continuation while at home of tuberculin treatment begun in an institution. We have proofs of this which ex cathedra statements to the contrary cannot shake. There will always be an urgent necessity of continuing at home the specific treatment of patients, whose stay in the institution has been broken off too soon.

But in the interests of the home treatment of these cases who have not been in a sanatorium we must go a step further. We desire that a gentle, gradual, reactionless tuberculin treatment should become an integral part of the home treatment of tuberculosis. Robert Koch wrote in the preface of the third edition of our book on tuberculin, "I should like to associate myself with the recommendation of the specific treatment in ambulant practice, for carefully selected cases only."

The difficulties of ambulant tuberculin treatment are doubtless still overestimated by many; in any case they are not so great that they cannot be overcome by any doctor, who is confronted every day with greater difficulties. The demand for a more active

home treatment is quite justified. The practitioner must be, that is to say, must again become, the centre for the treatment of tuberculosis in his district. This is rendered essential by the ubiquity of tuberculosis.

6. PROPHYLAXIS.

Pulmonary tuberculosis is easier to prevent than to cure. Therefore the doctor has a double rôle to play; firstly to cure those affected by the disease, and secondly to protect the healthy from falling victims.

At the head of this chapter should be placed the words: *moda pèl*. No generally recognized prophylactic measures against tuberculosis can be enunciated as long as the views vary concerning the origin of tubercle bacilli, their modes of entrance and methods of propagation. The rival views, whether infection or predisposition plays the more important part in the production of tuberculosis, are also opposed. Further, the "infectionists" are not united among themselves. But at any rate there is abundant experimental, clinical, and pathological evidence that prophylaxis may be favoured in two ways.

The first method aims at limiting infection and preventing contagion. Thanks to the timely discovery of R. Koch we can recognize the enemy and his dispositions, and are "therefore in a position to stop him and attack him at his weakest point" (R. Koch).

The tuberculosis frequency has diminished considerably during the last twenty-five years. For example, in Prussia both the total deaths from tuberculosis and the relative proportion of deaths from this cause to the total mortality are the most favourable in the year 1909 since the earliest Prussian statistics (1875). The proportion has diminished one-half from 32.51 per cent., the maximum it attained in the year 1878, to 15.39 per cent.; and the absolute number was 60,784 in 1909, as against 88,283 in 1886. These figures are the more remarkable since the population has increased from twenty-eight to forty millions. In the whole German Empire the mortality from tuberculosis has constantly fallen, but not in such a marked degree.

We need not here consider whether we are justified in ascribing this decrease wholly, or only in part, to "antibacillary prophylaxis." It would also lead us too far to examine the almost colossal literature on the question whether Cornet's dust infection, or Flügge's drop infection, or v. Behring's theory of the origin of human tuberculosis from the gastro-intestinal tract in the earliest years of life, is most important in relation

to prophylaxis. But it is certain that no theory covers the whole ground.

Let us not in quarrelling with others forget the possibility of all three sources of infection, for disunited leaders always lose the battle. Let us also beware of individual fails in the battle against the tubercle bacilli. Above all, we must not let it develop into a battle against the patient; for that will only lead to consoling, hushing up, and driving away of the phthisical cases, in whose hands prophylaxis really lies; and it is the majority that will have to suffer. The correctness of the phrase "no tuberculosis without the tubercle bacillus" is the justification of all antibacillary prophylaxis.

The chief dangers arise from the thoughtless spitting of tubercular persons, and from careless coughing with an uncovered mouth. Against the first there is only the general direction that everyone with a cough and expectoration is dangerous, and must be educated into being harmless. For this purpose spittoons filled with disinfecting fluid are useful in closed rooms; while patients in bed should be provided with sputum mugs, and patients who are getting about with pocket sputum flasks. The sputum thus collected must be destroyed by burning, by adequate boiling, or by the addition of strong disinfectants. Spitting in the streets must be entirely prevented, even with the help of the police. But light, sun, rain, and cold destroy the virulence of tubercle bacilli, hence the extremely low tuberculosis mortality of the Berlin street sweepers.

The handkerchief will be used as a receptacle for sputum by people who have an insurmountable horror of the pocket flask, which no argument can overcome. It is certainly a lesser evil than indiscriminate spitting, but advice on this subject is required. The handkerchief that is used in this way should be changed at least once or twice a day, and should be carried in a separate pocket, which should have a lining of waterproof stuff. After use it should be placed directly in a disinfecting solution (2 per cent. raw lysol-form) for twenty-four hours. Changeable pocket linings for coats, trousers, and ladies' dresses should be recommended for the pocket reserved for the sputum flask or handkerchief. Paper handkerchiefs of an absorbent nature, to be placed in watertight bags, may also be recommended; they have only to be completely burnt after use.

Besides the proper disposal of the sputum a discipline of the cough is important. This must be attained by frequent explanations and a general diffusion of a knowledge of the laws of decency. The healthy must not be roughed over unnecessarily by the com-

sumptive; this applies specially to intercourse in families, between man and wife, parents and children, servants and children, &c. The patient must be taught to close his mouth when coughing, and to hold his handkerchief, and not his hand, in front of his mouth. In any case it is better that the hands be very frequently washed, especially before meals as in sanatoriums.

Further, the tubercular patient must be educated as to cleanliness of the body, the beard, and the clothes. The danger of bringing bacillary material into the house on dresses and feet may be obviated by wearing dresses that clear the ground, and by changing the boots on entering the house. Specially strict rules must be observed by households where there is a case of chronic phthisis, who is still working. A light bedroom without hangings and upholstered furniture, a separate bed, and frequent damp cleaning are required. In more serious or bedridden cases the doctor must attempt isolation as far as possible. Where the most effective isolation in hospitals is not possible, a room separate from the family must be aimed at. Owing to the length of the illness and the scarcity of house room this is not always possible. Therefore in each case the imperfect isolation must be supplemented by disinfection, which in cases of tuberculosis is "both of the utmost importance for reasons of sanitation and of political economy" (Kitchner).

The frequent disinfection of the sick bed, which cannot be ordered by the sanitary officials and is not spontaneously done by the family itself, often does not occur to the mind of the doctor. And yet it is more important than all the other means of disinfection. Infected materials must be dealt with by burning, boiling, or disinfectants.

Clothes, bed-linen, towels, and especially handkerchiefs must be disinfected by boiling, or by soaking from twelve to twenty-four hours in a 2 per cent. lysol solution. According to the observations of the Berlin Institute the ironing of linen only produces disinfection if it is done on both sides, and if the iron is very hot (about $250^{\circ}\text{C}.$). Spores are not certainly destroyed even at this temperature. Articles such as crockery, glasses, forks, and knives must be boiled, or at least cleansed with hot soda solution. The room, especially the walls and floor around the bed, must be frequently cleansed with damp clothes, and scrubbed with hot, strong, soft-soap solution. If the patient is removed to a hospital or sanatorium then the room must be thoroughly disinfected, together with the bed, bed-clothes, pillows, clothing, furniture, curtains, hangings, &c. This is best done by a formaldehyde process, after a preliminary mechanical cleansing with a brush and

disinfectant. Though it is not ordered by law, yet it is the duty of the doctor to see that it is done in the interests of the healthy members of the family. The same must be done when cases of advanced phthisis die, or change their lodgings. Kirchner correctly says that "when the dead man is carried out of the house a fatal inheritance is left behind for those who live there after him. Numberless healthy families have moved into such houses, and after a short time been attacked by tuberculosis." In Germany it is now provided that such disinfection should be carried out at the expense of the community. For this purpose the co-operation of the practitioner is required, but care must be taken that the patient is not injured by the communication of professional secrets.

After the death of a phthisical person, besides the formaldehyde disinfection, it is now a legal requirement that all unwashable clothes, beds and mattresses, blankets, curtains, carpets, table-cloths, &c., should be removed for steam disinfection, as formaldehyde gas cannot be relied upon to kill all the bacilli in them.

The means for this disinfection after death are sufficiently provided by the notification of the practitioner, and the powers of the sanitary authorities, but what we must now press for is the establishment of a similar method of compulsory disinfection each time that an advanced case of phthisis changes his abode, which is an indispensable weapon required in our fight against the disease.

These questions are worthy of detailed considerations because facts have forced us more and more to the conclusion that the prophylaxis of tuberculosis is most important in childhood, and especially in the earliest years, and that it is this age that above all must be protected from severe, or even moderate, family infections from phthisical relatives. In order to obtain the exclusion of infection from the household the co-operation of the mother is first of all needed, whose immediate duty it is to look after both the house and the children. For this reason it is desirable to educate our school-girls of every class as housewives, and to teach them to become efficient helpers in procuring the proper hygiene of the house and the child, from the point of view of the prophylaxis of tuberculosis. Since the law is at present insufficient, doctors must continue the effort to enlighten the public, especially by means of the education of women in anti-tubercular matters. And this is largely work for the general practitioner.

It is idle to waste time over medical disputes whether sana-

toriums or dispensaries or hospitals have the greatest prophylactic value. We are of the opinion that it is not a matter for comparison. Hospitals isolate the most dangerous cases, but can still only receive too small a number. The effect of the dispensary in tracing cases of tuberculosis, and in improving house sanitation, is also very great, and there is room for a vast extension and multiplication of these agencies. The sanatoriums free one section of their inmates from bacilli, and so discipline the other section that they become harmless bacilli carriers; while all the patients should be, when discharged, apostles of a healthy mode of life. We therefore cannot do without any of these three agencies.

The prophylactic measures against the danger of infection from tubercular animals and articles of food containing bacilli are discussed in the section on Tuberculosis of the Digestive Tract, and in that on Tuberculosis of Childhood. We will here indorse, however, the opinion of Abel that "hygienic regulations as applied to articles of food should be enforced by general laws, and not by local police orders; and that they must go hand in hand with the enlightenment of the public concerning food supply."

Flies, as the possible carriers of tubercle bacilli, deserve more attention than they have received, since there is proof that flies in houses containing a serious case of phthisis may be considerably infected with tubercle bacilli; and there are many possibilities of these organisms being conveyed to men. Most important is the probability of infection of articles of food by transference of material containing bacilli, or by the deposit of excretions from the fly on the food. Lord has shown that in 2,000 fly spots, deposited in three days by thirty flies fed on tubercular sputum, there must have been between six and ten million tubercle bacilli, which retain their power of infection for at least fifteen days. Therefore attention must be paid to the removal and disinfection of sputum, to the covering of sputum mugs, and the keeping of food in safes inaccessible to flies.

The second method of prophylaxis aims at teaching the healthy how they can protect themselves from infection, and in raising the power of resisting the contagion of those who are threatened. Therefore we have not only to educate the patient so that he is no longer a danger to the community, but also to instruct the healthy how they can avoid the infection of tuberculosis, which they can do to a certain extent as soon as they are old enough. We consider that enough instruction of this sort has not been given to our growing youth in schools. We do not mean by this that an overwhelming fear of bacilli is to be fostered. It should be known that intercourse with a patient who is seriously

ill, but cleanly in his habits, is less dangerous than with a slightly affected but uncleanly person; that the use of the sputum flask by the patient is not a danger, but a protection, to others; that close contact with a tubercular person in the same house, and even in the same room, does not necessarily entail a danger of contagion; and that not every bacillus which reaches the lungs need cause tuberculosis.

Every healthy organism has a number of forces automatically working for protection, and which are capable of rendering harmless certain infections. Nevertheless the body may succumb if the infection is severe or continuous, or if the organism is temporarily weakened, or is habitually predisposed to the disease. We are apt to consider such a transitory or permanent lowering of the defensive powers as an inherited or inborn disposition to tuberculosis. Individuals may be protected by warning them firstly to avoid close continuous intercourse with phthisical patients, especially uncleanly persons living in close, unhealthy rooms, secondly to maintain a good state of general bodily health, and thirdly to raise their resistance as much as possible.

These prophylactic means can be employed not less often in everyday life than the antibacillary measures, and are applicable to all classes of society, and to all ages. For example, the question of marriage of tubercular persons often arises. We are obliged to discountenance the marriage of recent cases of pulmonary tuberculosis of both sexes, for reasons which have already been given, and also that of women suffering from the more chronic forms of disease, in spite of favourable social conditions. The scientific principles of heredity are not sufficiently known to justify the legal prevention of marriage by consumptives on account of racial reasons and the transmission of the predisposition. Another example of everyday occurrence is that we are often required to assist in the choice of an occupation for a weakly youth, burdened with a bad family history. It may be assumed that he will probably get stronger and remain well if he undertakes a light occupation chiefly in the open-air; while under the same conditions of infection he will fall a victim if his calling compels much exertion, or a sedentary life in dusty or confined atmosphere. The school and family doctor could do much good in this direction.

Hardening the body, exercises, sport, care of the mouth and teeth, appropriate clothes suitable to the season increase the individual power of resistance against injurious influences, and remove already existing weakness of the organism. On the other hand insufficient food, alcohol, unhealthy home conditions,

injurious occupations, uncleanliness, tight clothes, hampering the breathing, &c., prepare the soil to receive the bacilli. Many of these points involve questions of hygiene which may be dealt with by the Legislature. We need only mention the housing difficulty, an example of which we find in the fact that in Berlin over half a million of people live in houses in which every room is occupied by five or more people. According to the official statistics of Berlin 228 cases who died of consumption in the year 1903 occupied till their death the same room as two other persons, 164 the same as three others, 153 as four, seventy-five as five, forty-five as six, twelve as seven, six as eight, and six as ten or more other people; and that the same room served for sleeping, living, and eating. Altogether 8,229 persons were living in one-roomed dwellings with consumptives. In Schönberg, near Berlin, a house inspection of 400 dwellings containing 439 consumptives produced the following results: In 103 cases the patient lived with his family in one room, kitchen, or corridor; in thirty-nine cases there were five to eight people in a single room; only forty-six patients had their own bedroom separate from the healthy, and thirteen of these slept in the kitchen; twenty-six shared their couch with children or adults.

The housing question is therefore of immense importance for the prophylaxis of tuberculosis, and it is one which the medical profession must not weary of emphasizing. The decrease of the tuberculosis statistics in England show that the care of the dwelling is one of the most important weapons in the fight against consumption; the quicker and the more completely the prevailing conditions can be remedied, the smaller our difficulties will become in the future.

Besides aiming at a wide measure of housing reform we must never relax our efforts towards attaining an effectual domestic prophylaxis against tuberculosis, the essential points of which have already been enumerated, and which should form part of the instruction given in schools. The house is not only the production of the architect, but also of those who live in it. When we remember that tubercular human beings are the source of tuberculosis, then "it becomes less important how the house is built than how it is kept" (Kirchner).

Closely connected with the housing question is that of alcohol. The man who comes home from a dusty workshop and finds no comfort is only too apt to seek company in the public-house, and warmth and stimulation in alcohol. The following data bear on the connection between alcoholic excess and the tuberculosis mortality: The mortality from tuberculosis in per-

sons over thirty is from two to three times as great amongst males as amongst females, the latter being less addicted to alcohol. At greater ages the excess of tuberculosis mortality among men as compared with women becomes greater. In other countries the tuberculosis figures are highest in those districts in which the consumption of alcohol, and especially of spirits, is greatest per head. There is a marked excess, too, of the mortality of tuberculosis among those occupied in the spirit trade, compared with other occupations which also entail confinement in close rooms but without exposure to alcohol. In Germany the tuberculosis mortality among brewers is more than double, among publicans more than three times, and among barmen more than four times, that of the average for the German Empire. The reasons are obvious. Chronic alcoholism lowers the powers of resistance to infection of the whole body, and especially of the lungs. Then when the bacilli have entered, the protective forces which should oppose them are weakened. Also when there is a considerable part of the income sacrificed to alcohol the outlay on food, housing, &c., will fall below what is necessary. Above all, parents and educators must be shown that alcohol does not build up but destroys the tissues, and that alcohol in any form or any quantity must be forbidden to children and youths. If they are allowed to take alcohol regularly, to strengthen them or for other reasons, a race of candidates for consumption will be produced. So the fight against tuberculosis includes that against alcohol.

A large amount of pulmonary tuberculosis is the result of other illness and disturbances of general nutrition (anæmia, chlorosis, asthma, &c.); also of non-tubercular pulmonary diseases (bronchial catarrh, pneumonia, whooping cough, pneumoconiosis), of non-tubercular affections of other organs (diabetes mellitus, syphilis, measles, influenza), and, lastly, of tubercular affections of other organs than the lungs (pleura, glands, bones, and urino-genital organs). These will be considered in other sections, especially that on scrofula and tuberculosis of infancy.

R. Koch shortly before his death drew attention to the spread of tuberculosis in country districts, and Jacob has shown the very defective hygiene which exists in them even to a greater extent than in the towns. The chief factors are unhygienic sleeping apartments, unhealthy schoolrooms and inns, insufficient feeding of the children, alcoholism, uncleanness, absence of any care of the skin and teeth, and inadequate clothing, all leading to a spread of contagion, which is un hindered by any prophylactic measures, until actually whole villages have the disease. The individual doctor with the best will can do little here; far-reaching

radical measures are required to stop what has become an epidemic. A network of dispensaries under energetic organization would deal best with the evil.

There remains to be considered the question whether for the purpose of prevention most attention should be directed to infection or to predisposition. It is certain that both factors are not of constant value, but vary considerably according to time and place. It is clear that without previous infection no tubercular disease is possible, but infection and disease are not always identical, and the one does not always follow the other, but the occurrence of disease depends in the main on the constitution. It can never be established in a single case whether infection has led to the disease in the absence of predisposition. On the other hand we are agreed from the results of *post-mortem* examination, and the cutaneous tuberculin test, that in spite of the existence of infection tubercular disease is frequently absent.

Practically the conditions in every case are such that "family infection" and "family predisposition" cannot be distinguished or separated from each other in their results. We must in the interests of the coming generation try and arrest family and house infection by all means in our power, and at the same time combat family predisposition just as energetically, so that the individual may not fall a victim to infection received outside the family.

In prophylaxis extremes are even less justified than in treatment. We therefore exhort infectionists and predispositionists to work together for practical purposes; *in studio latissime ibit*. For the development of phthisis both infection and individual predisposition are necessary; therefore our preventive measures must be directed against both.

CHAPTER III.

Tuberculosis of the Pleura.

THE anatomical and physiological connections of the pleura are of importance in relation to the occurrence of tuberculosis. The pleura is a kind of large lymph-sac with innumerable lymphatic apertures; it communicates with the glandular system, and is susceptible to tubercular infection to a slighter degree than the lungs. In conditions of increased infection the power of absorption may fail and the pleura become affected, but it possesses a natural means of defence in the form of inflammation. Inflammation of the pleura is thus an effect, by means of productive and exudative changes, to weaken and make powerless the specific infecting agent.

From the arrangement of the pleura it follows that in nearly all cases the tubercular infection is carried to it from the lung. Either a tubercular focus in the lung breaks through into the pleural cavity, or it extends to the pulmonary pleura and thence to the parietal pleura by continuity. On the other hand the lymphatic channels between the pleura and the neighbouring organs may permit the entry of tubercle bacilli into the pleural cavity. The blood-stream is rarely the path of infection.

1. TUBERCULAR PLEURISY.

Anatomical Changes.

The anatomical changes in tuberculosis of the pleura are the same as in pulmonary tuberculosis. Only from the arrangement

and structure of the pleura exudation is usually more important and tissue formation or necrosis less so.

If the tuberculosis of the pleura occurs without being accompanied by inflammation it takes the form of a simple eruption of tubercles. Miliary tuberculosis of the pleura may arise as a part of general miliary tuberculosis, or as a localised formation of miliary tubercles over a chronic tubercular nodule in the lung. The accompanying exudation is nearly always sanguineous.

The second, and on practical grounds more important variety is the appearance during chronic pulmonary tuberculosis of a tubercular pleurisy. Inflammatory changes of a productive or exudative character predominate within the pleural surface being necessarily affected.

Tubercular pleurisy takes many forms, from a localized fibrinous exudation to an extensive thickening and adhesion of the pleural surfaces; while different grades of inflammatory exudation into the pleural cavity may occur. These forms, like those of pulmonary tuberculosis itself, are extraordinarily variable and fluctuating. The old division of dry and exudative pleurisy is useful on practical grounds, though there are also many transitional forms.

By dry tubercular pleurisy is meant the purely fibrous form in which there are slight circumscribed thickenings of the pleura, or a fine coating of fibrin, which with greater exudation becomes an extensive, thick, shaggy membrane. It usually accompanies slowly developing disease of the apical region, and is frequently found on the para-vertebral portion of the apex of the lung, and at the base, especially in the postero-lateral region. The fibrinous exudation may be either completely absorbed or become organized with granulations and connective tissue. In the granulation tissue covering the pleura tubercles also appear. As a residuum of old fibrinous pleurisy one finds at post-mortem examinations fibrous nodules, circumscribed thickenings of different size, and adhesions in the form of strands or bands or extensive cohesions of both pleural surfaces. These changes are found in nearly all cases of phthisis, especially at the apices of the lungs.

When extensive masses of fibrin become organized very hard fibrous cicatrices, often 1 or 2 cm. thick, are formed, which by the deposition of lime salts often become calcified. These changes are what is known as fibrous pleurisy, or if both pleural surfaces are united together, as adhesive pleurisy. Circumscribed adhesions may become drawn out in the form of bands between the chest wall and the lung. If between the adhesions there are the remains of an effusion the term *sacculated pleurisy* is used.

The dry pleurisy is the same etiologically as the exudative form, the tubercular pleurisy with exudation. The exudation may be serous, sero-fibrinous, or purulent, or each variety may become hemorrhagic from the mixture of blood out of the distended capillaries.

The purely serous exudation is not different from that found in non-tubercular cases. As a rule there are neither tubercle

bacilli to be discovered in the exudate, nor specific changes in the pleural cavity. It is often due to a toxic irritation of the pleura proceeding from an existing tuberculosis of the lung.

In the serofibrinous inflammation there is a variable mixture of serous exudate and fibrin. The fibrin appears as a delicate, fine, membranous deposit on the wall of the cavity, and as finer fibrinous flocculi in the exudation fluid. Tubercle bacilli can be discovered in the exudate.

The quantity of serous and serofibrinous exudate is usually about half to two pints, but may reach three to five pints, and compress the lung severely. The compression of the lung may reach such a pitch that it forms an airless, airtight stump. According to the amount of exudate, displacements of the neighbouring organs, the heart, the diaphragm, the liver, the stomach, the colon, &c., may occur. But adhesion of the lung to a neighbouring organ may prevent displacement. If there is only an incomplete absorption of the exudation there will be more or less extensive organization and new formation of blood-vessels and connective tissue which have already been described under dry pleurisy. Long-continued pleurisy with exudation frequently leads to marked thickening.

Purulent tubercular pleurisy or tubercular empyema may be due to tubercle bacilli exclusively, or to the entry of other organisms. It is not rare to find an empyema free of organisms in tuberculosis, which has been explained as the result of the chemical irritation of a bacterial toxin.

The condition favourable for the production of a tubercular empyema is the occurrence of a tubercular cavity close under the pulmonary pleura, a situation where it may also cause a pneumothorax.

In purulent pleuritis the cavity is covered with a pyogenic membrane; sometimes a fibrinous deposit permeated with liquid pus settles at the bottom of the pleural space. In the pus tubercle bacilli can generally be discovered. In these cases also there may be a partial organization and connective tissue formation. When these form septa and break up the purulent exudate, one speaks of a loculated empyema.

Symptoms and Course.

As to the frequency of tubercular pleurisy there is a great difference of opinion. While Landouzy recognizes 98 per cent. of all so-called simple pleuritis as tubercular, according to Stintzing not more than half of them are; Jakob and Pasavitz put it at 30 per cent., v. Sokulowski at only 2.8 per cent. The estimation of 90 per cent. seems to be most nearly correct, since extensive statistics

show that "idiopathic" pleuritis are in about half the cases tubercular, and indeed regularly so during the first five years of life.

In any case pleurisy, in all its anatomical forms, is very frequently tubercular. It is nearly always secondary, usually to pulmonary tuberculosis, more rarely to tuberculosis of the bronchial and mediastinal glands, or of the vertebrae, the ribs, the peritoneum, or the pericardium. Or the tubercular infection may be transported to the pleura by means of the lymphatics from a more distinct source, as for example a tubercular rectal fistula. Pleurisy may be merely a part of a general miliary tuberculosis.

The possibility of a primary disease is allowed; that is, the bacilli may reach the pleura through a penetrating wound of the thorax, or by way of the tonsils, bowel or lungs, without affecting these organs; but such an occurrence has no practical importance. The cases in which an apparently sound person is attacked with pleurisy and afterwards manifests signs of lung tuberculosis are to be explained by a latent lung tuberculosis, which first produces pleurisy and later shows itself in its true form.

Men suffer from tubercular pleurisy much more often than women; according to v. Ziemssen in the proportion of sixty-five to thirty-five. As predisposing causes exposure to cold and injury have a certain force. A meteorological influence is shown in the fact that there are most cases of pleurisy in January and fewest in the autumn months.

Miliary tuberculosis of the pleura gives slight or no clinical evidence, so long as it does not lead to exudation or plastic inflammation. But it has a marked tendency to set up a spreading miliary tuberculosis. It has a fairly acute course.

Dry tubercular pleurisy generally produces very characteristic symptoms. They consist of local feeling of pressure and constriction in the chest, and a dry irritating cough. Painful feelings of pressure, especially over the apex of the lung, are usually due to a localized dry pleurisy. The pains are increased with each inspiration, so that the respiratory movements are intentionally restrained; the cough is anxiously repressed, or the pain lessened by fixing the diseased side. It is a characteristic sign that the patient, even if the pleurisy is due to a genuine pneumonia, nearly always lies on the affected side. Fever is absent or slight in amount; existing tubercular fever is generally augmented.

Percussion usually gives no clear evidence in dry pleurisy, provided that the lung near the pleuritic nodules is normal; sometimes with lighter percussion the note seems to be shorter or weaker.

The breath sounds are weakened if there are adhesions or fibrous layers between the pleural surfaces; in recent cases the inspiratory sound may be increased or it may be discontinued with the pulse rhythm. Inspiratory sounds intermitting with the pulse rhythm along the lower border of the lung are a frequent sign of dry pleurisy (Brock); which may be explained by the fact that adhesions and inflammatory products in the pleura hinder the uniform expansion of the underlying lung. More definite is the friction rub heard with inspiration and expiration; it may frequently be also felt. Its character differs with the varying nature of the inflammatory roughening, which according to Prantzel may be villous, shaggy, or areolar, or like a coating of hoar frost, or in thick lines, or like the marks on a sandy seashore, or like the dorsal surface of an ox-tongue.

Dry pleurisy, with its sharp pains, is frequently in tuberculosis the precursor of an exudation, more seldom of a hæmoptysis, a pneumothorax, or of a sudden recrudescence of old, apparently healed nodules in the lung. Local pleuritic irritation may also occur over healed foci, without stirring them into activity, usually in the neighbourhood of cicatricial contraction, sometimes on the affected side, sometimes on the other; the neighbourhood of the heart is a favourite spot.

Dry pleurisy may run a varying course. It may last for years in the same condition; or may be completely absorbed, leaving only a slight staining or thickening of the pleura. In other cases it leads to adhesions of the pleural surfaces, or it may develop into the exudative form.

Tubercular pleurisy with exudation also usually begins with stabbing pains, increased irritative cough, and shortness of breath. While the pains and the cough diminish, when the increasing formation of fluid separates the pleural surface the shortness of breath increases, and in rare cases reaches the grade of orthopnea. The amount of shortness of breath depends on the rapidity with which the effusion forms, and on the respiratory capacity of the other lung. Slowly developed effusions, even if large in amount, produce no marked difficulty of breathing if the other lung is sound or only slightly affected. It is therefore not so rare for patients with a tubercular effusion to perform heavy work, and the pleurisy may not be discovered on a superficial examination. Large effusions produce marked cyanosis from pressure of the fluid on the heart and vessels. The temperature is raised, usually to between 102° F. and 103° F.; both slight and high fever are common.

On inspection the increase of the affected side can be detected.

the intercostal spaces are enlarged, and in large effusions rather bulged; the affected side lags behind in inspiration or remains motionless.

Lately Jacobæus has employed the cystoscope used by Kelling for the serous cavities for the direct observation of the pleural changes. After removal of the exudate and the introduction of filtered air or nitrogen, the intensity of the inflammation and the presence of tubercular nodules, &c., may be observed with the thoroscopes.

The procedure is shortly as follows: After subcutaneous, intramuscular and peritoneal anesthesia, and after cutting through the skin, a trocar is introduced, preferably above the sixth rib, into the pleural cavity. The incision must be large enough to admit a No. 12 Nitze's cystoscope. After the fluid is removed in part, blown out, the cystoscope is introduced and the pleural cavity illuminated.

The percussion note over the effusion is absolutely dull and flat, and above the area of dullness tympanitic, on account of the compression of the lung tissues. The limits of dullness vary with the position of the patient, the upper limit is horizontal in a patient who is getting about, and in the recumbent patient higher behind than in front or in the axilla. Large effusions may reach up to the clavicle in front and the spine of the scapula behind.

On auscultation bronchial breathing is heard over the dullness, and weak bronchial breathing over the compressed lung. Vocal fremitus is weakened or lost. Over the tympanitic area above the effusion bronchophony or egophony may be heard. The explanation is that the voice sounds are directly conducted from the broncho-tracheal air passages by the compressed lung tissue to the chest wall.

The displacement of organs is more or less obvious according to the amount of exudation; the heart is drawn to the sound side, the diaphragm lies lower, and the liver also in right-sided effusions. The displacements are caused both by the pressure of the effusion, and by the loss of elasticity of the compressed lung.

The urinary secretion is much diminished while the effusion is forming; the pulse rate is persistently increased.

The different forms of exudation do not alter the clinical picture. Only tubercular empyema usually causes higher and more lasting fever with more marked daily remissions; though encysted purulent effusions may be quite without fever. However a free empyema may be quite without fever also, and a purely serous effusion may cause high fever.

Bilateral effusions and pulsating pleurisy are very seldom met with in tuberculosis.

As to the course of tubercular effusions it may be first remarked that large effusions may form quite unnoticed by the patient. In other cases there may be only general symptoms, as heaviness, loss of appetite, gastric oppression, and other symptoms which give rise to a suspicion of commencing phthisis. As the lung condition causing the effusion is often not recognized it will be very difficult to say how long the symptoms of the latter have lasted.

There is no relationship between the character of the pulmonary tuberculosis and the course of the tubercular pleurisy. Latent lung tuberculosis may be the starting point of pleurisy, and extensive cavities may leave the pleura unaffected. Very chronic phthisis may set up a most acute and frequently relapsing pleurisy, while rapid lung disease may be associated with very chronic pleurisy. The duration of tubercular pleurisy may be measured by weeks or months. The appearance of an effusion especially prevents an accurate forecast, just as pulmonary tuberculosis has a variable course which cannot be foretold, so also has tubercular pleurisy.

Tubercular empyema in adults occurs chiefly as a complication of suppurative bone disease, or in connection with pyæmiæ, thorax, pneumonia, or influenza infection. Empyema causes severer symptoms usually than the non-purulent effusions. The fever is higher, irregularly intermittent, sometimes accompanied by chills; the weakness is greater, and the pulse very rapid. Sometimes there is slight œdema of the affected side. If the pus is not removed by operative measures in rare cases absorption and inspissation of the pus may occur. Usually the pus breaks through either into the lung, or more seldom into the peritoneum or other organs, or penetrates the chest wall (empyema metastatic). From rupture into the lung a pyopneumothorax may result.

A short account must be given of diaphragmatic, pericardiac, and interlobular pleurisy which are not uncommonly observed in tuberculosis either in the form of purulent or non-purulent inflammations.

Diaphragmatic pleurisy is of definite practical importance as it may simulate abdominal disease, and the non-recognition of its purulent form may have severe consequences. The usual symptoms of pleurisy are either quite absent or are not clear. The affection, which is localized between the base of the lung and the diaphragm, begins with pains in the side, painful coughing, and slight difficulty of swallowing. An onset with severe dyspnoea or angina has been observed by Andral. On palpation the

affected region is very tender. There are two most important points of tenderness. The first, described by Guéneau de Mussy as the "diaphragmatic spot," is a tender point at the point of intersection of a vertical line drawn through the outer edge of the sternum and a horizontal line at the level of the tenth rib. The second is along the course of the phrenic nerve in the neck on the same side. Further, there is the "respiratory abdominal wall reflex" of A. Erlenkief, a sudden contraction of the upper part of the rectus muscle of the same side on deep inspiration, sometimes also a reflex contraction of all the muscles of the abdominal wall. Other symptoms may be right-sided shoulder pain, pain on swallowing in the region of the cardiac orifice, gastric pains, vomiting, or hiccough. Osler recognizes as particularly characteristic of diaphragmatic pleurisy marked subjective symptoms with slight physical signs. A radiographic examination will make the condition clearer. A marked diminution or irregularity of the diaphragmatic movement will be seen. Sometimes also bands of adhesions or projections or bends may be seen in the diaphragm; while the complementary space is small and indistinct or quite unrecognizable. These changes in the diaphragm are not at all rare, and confirm the diagnosis of diaphragmatic pleurisy.

Pericardial pleurisy is also of importance, left-sided dry pleurisy affecting that portion of the pleura that overlaps the pericardium. The symptoms consist of pain in the region of the heart, palpitation, and shortness of breath; while objectively weak or clear friction sounds are heard at the apex and left border of the heart, which accompany and partly obscure the heart sounds. They are characterized by being both diastolic and systolic, sometimes they diminish with inspiration and become clearer with expiration, if the heart's apex beat is weak or imperceptible, or is drawn in with systole. With the Röntgen screen sometimes fine streaks are seen on the left side of the heart shadow, occasionally in the form of a network. These thicken the heart shadow, and are put in movement with each pulsation; or they may pass from the heart to the shadow of the diaphragm. These cases are usually due to a chronic, relapsing, tubercular pleurisy; they cause confusion with cardiac disease on account of the breathlessness and other symptoms, and are infrequently are ascribed to neurasthenia or cardiac hypochondriasis (Breckel).

Interlobar pleurisy with effusion occurs when the edges of the lobes are glued together on account of previous inflammation; fluid may then collect in the division between the two lobes, even to the extent of $\frac{1}{2}$ pints or more. Sero-purulent and purulent

exudations preponderate, and are not rarely found as antiseptics as complications. There may also be large serofibrinous effusions, for the diagnosis of which a knowledge of the topographical anatomy of the interlobar sulci is necessary. Effusions of more than a pint usually can be detected at the side of the thorax in the axillary line; here they lie directly against the parietal pleura, or are covered only by a thin layer of transposed lung, and may be reached with an aspirating needle.

The onset is usually sudden, with stabbing pains, fever, chills, cough, and dyspnea. On physical examination there may be at first nothing detected, then dullness appears in the form of a slanting or transverse band following the line of the interlobar sulcus forwards from the vertebral column till it is lost in the liver or heart dullness. This band, which may be from $\frac{1}{2}$ to 4 in. thick, is as it were suspended between two areas of resonance above and below. Traube's space on the left side remains clear. On examining with the Röntgen ray the "suspended" shadow may be very clear, or it may be obscured or obliterated by old pleural thickenings. In more than 50 per cent. of cases the exudation makes a way into the lung, and is expectorated in mouthfuls, either in a sudden gush or by degrees. In interlobar empyema the expectoration is very fetid; the patient himself may recognize the commencement of the entry of pus into the lung by the foul taste or unpleasant smell of the expired air. The symptoms of interlobar pleural exudation, namely, a band of dullness between two resonant areas, a suspended radiographic shadow, and expectoration in mouthfuls are so inconstant and indistinct that the diagnosis is often very difficult and not uncommonly impossible.

Diagnosis.

Tubercular pleurisy is often of subordinate clinical importance, when overshadowed by the existing pulmonary tuberculosis. But there are cases in which a dry pleurisy is the first symptom which brings the patient to the doctor, so that it is often of importance for early diagnosis. Pains in the front of the chest, stabbing pains in the side, sensations of pressure or dragging over the apex of the lung are almost regular subjective signs in commencing pulmonary tuberculosis. They are dependent, since in the parenchyma of the lung there are no sensory nerves, usually on pleural changes. In tubercular patients, who have not had the slightest pain, one can be sure that the pleura is intact. On the other hand stabbing or dragging pains, which remain localized at a fixed spot, indicate pleural or sub-pleural changes.

As a sign of military tuberculosis of the pleura Jorgensen has

described a particularly soft and delicate rub; it is usually masked by the louder respiratory sounds.

The diagnosis of dry tubercular pleurisy is not difficult, if there is sufficient respiratory movement to rub together the pleural surfaces roughened by fibrinous exudation or by an eruption of tubercles. The friction sound thereby produced, from the lightest rub to the loudest grating or creaking sound, is not easily mistaken. The pleural rub may be heard during the whole respiratory phase, usually in inspiration, occasionally in expiration; in this it differs from the fine sub-crepitant râles over the apex, which are always loudest in the second half of inspiration, when the entering air reaches the bronchioles and alveoli. The pleuritic rub ceases when the breath is held; the more marked forms of friction can be felt.

Rubs are not influenced by cough, but may often be increased by pressure on the intercostal space. They also seem to be nearer the ear and more superficial than the sounds produced in the lungs. At the same time it is possible to mistake the sound. We may mention here a fine crackling râle heard along the margin of the lung, especially in the axillary line between the fifth and eighth ribs. They are sometimes pleural, the result of a fresh fibrinous exudation, sometimes expiratory râles from hypostatic, atelectatic or emphysematous changes in the lung. The latter, however, are only heard in the second half of inspiration or at the height of inspiration (Turbin). Also rûg-wheel and systolic vesicular breathing may be extremely like pleural sounds. A certain distinction sometimes cannot be drawn between pleural sounds and catarrhal râles; sometimes the pleuritic sounds disappear if the patient lies on his face. Also on radioscopic examination alterations of movement may be seen in dry pleurisy, so that Williams's symptom, diminution of the diaphragmatic excursion on the affected side from mechanical hampering of pleural adhesions or from implications of the phrenic nerve in the apical pleura, may be observed. Pleural adhesions that throw no shadow cannot be diagnosed, but bands of adhesions are easy to recognize, if, for example, they fix the diaphragm or draw it into a prominence on deep inspiration.

As the pleural surfaces become united the rub becomes weaker, and when adhesions are formed it can no longer be heard. Percussion also is usually negative. Marked pleural thickening may cause dullness, like effusions; in opposition to the latter, however, they draw the chest walls in, and draw the neighbouring organs to the affected side. The Röntgen rays show the pleural thickenings as broad plates, or isolated bands, the

density of the shadow being proportional to the amount of light they absorb. If the thickenings be near the screen, as when the light is transmitted from front to back, thick shadows will be seen; if they are further from the screen, as when the light passes from the back to front, the shadows will become less from the dispersion of the light.

From changes in the underlying lung dry pleurisy can easily be distinguished by the displacement of the margin of the pleural surfaces. The fine crepitations along the margin of the lung in the anterior axillary line, which Burgart considers an early sign of apical tuberculosis, are often due to pleurisy. If the adhesions increase at the same time as the rub disappears there will be displacement of the lower margin of the lung. Krieger considers this sign, as has been mentioned before, of importance in the differential diagnosis between tubercular and non-tubercular apical induration.

There is difficulty in diagnosing dry pleuritic changes of the upper part of the thorax, especially over the apex of the lung. Tenderness of the muscles of the shoulder girdle on pressure is a thoroughly unreliable sign. Friction sounds are produced here with difficulty, owing to the slight movement of the pleural surfaces, and are often masked by other sounds. Pleuritic changes at the apex are also specially liable to cause adhesions. Therefore fine crepitations that appear to be produced close to the ear should be ascribed to the pleura, if they are not extra-chloracic adventitious sounds (produced in the shoulder-joint or muscles). Sometimes by physical means alone the diagnosis is not possible. If an alteration in the position of the apex can be detected, if the side hugs behind an inspiration, if the suprasternal fossa is drawn in, and if the patient complains of pains or tenderness in this region, then the diagnosis of dry pleuritic adhesions at the apex may be made; and that in the vast proportion of cases is the same as a diagnosis of apical lung tuberculosis. So that these signs may be useful for early diagnosis.

A differential diagnosis from intercostal neuralgia may be required. In this condition the pains are increased by bending the body to the affected side, which diminishes the pain of dry pleurisy.

If after extensive examination there is a doubt as to the aetiology of dry pleurisy the subcutaneous tuberculin test should be employed. In cases of dry pleurisy the general reaction is often completed by a focal reaction; the patient complains of more pain in the suspected side, and the friction sounds become clearer and more extensive during the reaction. The result of

such a local reaction is quite free from danger. We have observed in our cases, which number some hundreds, that the disappearance of the reaction is accompanied by diminution of the previously existing pains and difficulty of breathing, and it never resulted in an inflammatory effusion.

The recognition of a tubercular pleural effusion is usually easy. But there are cases in which there may be considerable difficulty in the differential diagnosis, especially if the previous history affords no indication as to how long the condition has lasted, or how it originated. Also in long-standing effusions there are often exceptional fibrous and fibrous changes in the pleural cavity which obscure the diagnosis.

Infiltrations of the lower lobe of the lung cause difficulty in the differential diagnosis. To distinguish pleural effusions from these Grocco's paravertebral triangular area of dullness on the sound side is very valuable. This so-called Grocco's triangle is met in cases of pleural effusion which are not encysted, reach the vertebral column and extend up as far as the eighth thoracic vertebra. There is on the sound side an area of dullness of triangular shape, which comes and goes with the effusion, and is never found in infiltration of the lung.

The apex of the triangle, two sides of which are formed by the dome of the diaphragm and the vertebral column, lies at the level of the bar of the fluid in decubitus; the hypotenuse runs from this point in a sloping line downwards and forwards to the base of the lung, its outer end, which corresponds to the lower border of the lung, being about 4 to 5 in. from the middle line. The triangular dullness is best defined by the highest percussion of the patient sitting up in bed; lying on the affected side causes it to disappear or become indistinct.

The phenomenon was first observed by Grocco in 1902, and made more widely known by Roachburn in 1906. The cause of it is not yet clear. Examination with the Roentgen rays shows that it cannot be explained by displacement of the mediastinum; it is more likely to be due to an indirect influence affecting the ribs. The vertebral column acquires its normal clear note from the uncompressing forces lying on both sides; when effusion is present the compressing forces is absent on one side, and the lower the percussion is carried downwards the more the vertebrae and their immediate surroundings come under the influence of the fluid; at the upper border of the effusion the vertebrae still have a clear note from the lungs immediately above, but below this gradually falls (Nirch).

Grocco's triangle is very valuable for differential diagnosis, especially in those cases in which for any reason a diagnostic puncture is not possible. It must be remembered that this paravertebral dullness is absent in effusions undergoing rapid absorption, and may be present with a cavity in the lower lobe. Hamburger's paravertebral dullness in the form of a band, that is obtained by strong percussion, is of no importance.

For distinguishing between pleural effusion and crûpous pneumonia the condition of the vocal fremitus is very valuable; it is increased in pneumonia, weakened or absent in effusion. The test fails in very feeble patients with a weak voice, and also in the not uncommon combination of pleurisy and pneumonia and in obstruction to the bronchus. For the diagnosis of pneumonia we must then rely on the sudden onset with chills, the continuous high fever, blood-stained sputum, the area of dulness following the outline of a lobe of the lung, the nose not being absolutely dull, sometimes tympanic, no paravertebral dulness on the sound side, the complementary pleural spaces remaining free, crepitant râles at the onset and resolution, and loud bronchial breathing and bronchophony in the stage of hepatisation. In favour of effusion there are absence of rigors, frequently a slow onset, irregular but very high fever, enlargement of the affected side, absolute dulness with upper limit horizontal or sloping downwards and forwards from the spine, Gracco's triangular dulness on the sound side, dulness of the whole complementary pleural space, tympanic area, bronchial breathing, and resophony above the dull area. Circumscribed isolated effusions give various signs according to their localization.

Tumours of the mediastinum often cause difficulty in diagnosis. Growths of the lung, which are much more frequently carcinomatous than sarcomatous, and mediastinal tumours, generally sarcoma or lympho-sarcoma, are characterized by a very gradual formation of an irregular, usually extensive, area of dulness; it often extends across the middle line, and is not only due to the presence of the tumour itself, but partly to concomitant atelectasis and partly to chronic inflammatory changes in the lung. As a consequence of stenosis of the bronchus, in the intense dulness is added considerable weakness or complete absence of the breath sounds, with disappearance or diminution of the râles and other adventitious sounds. So that dulness of a whole lower lobe, with weak breath sounds and vocal fremitus, may be ascribed to a pleural effusion, when it in fact is due to a carcinomatous nodule implicating the wall of the bronchus of the lower lobe, and completely blocking its lumen, and to an indurative pneumonia consequent on the tumour. Intrathoracic tumours are generally revealed by neuralgic pains in the arm and shoulder, by dilated veins, or œdema in the skin of the chest, by symptoms of compression of the œsophagus or air passages, and by changes in the voice. Fever is usually absent.

The diagnosis is still more difficult if the pleura itself is involved in the new growth. There is then a pleural effusion

formed which displaces the neighbouring organs and completely masks the changes in the lung. Aspiration is here of value, as in spite of the removal of the fluid there still remains a large amount of dullness, and the patient is not sufficiently relieved. The fluid is usually blood-stained, and in some cases of new growth contains characteristically formed elements indicative of tumour, which in rare cases can be recognized by the naked eye.

In the microscopical examination of the cellular elements of tumour fluid care must be taken not to exclude small pleural endothelial cells with tumour cells. "Only groups of cells, the elements of which show a distinct polymorphism, such as is characteristic of tumour cells, must be relied on" (A. Frankel).

Lastly, diagnostic difficulty may be caused by the rare form of primary tumour of the pleura, the endothelial cancer of the pleura, also known as pleuro-endothelioma. Apart from the rare cases in which thick fibrous infiltration with excavated raised nodules form in the pleura, pleuro-endothelioma may be recognized by the rapid, untiring development and course of the disease, the effusion of a large quantity of blood, the rapid refilling of the pleura after aspiration, and the consequent small benefit therefrom received by the patient. Sometimes an unusual amount of blood in an effusion drawn from a patient, who before and after the aspiration complains of excessive pain, usually from pressure of the nodules, is against tubercular pleurisy, and gives rise to a suspicion of pleuro-endothelioma.

In every case the diagnosis of pleural tuberculosis in all its details is very difficult, and the Röntgen ray examination is of much service. By this means it may be seen that even quite small effusions, which on inspiration are otherwise clear, darken the phrenico-costal angle, as the fluid first fills the deepest part of the pleural cavity. With increasing effusion the upper limit of the fluid takes a curved shape (Damoiseau's line), being higher in the axilla than in front and behind. With large effusions, besides the marked darkening of the lung shadow, there may be seen the characteristic displacement of the front of the mediastinum above and the posterior part below to the sound side, the heart being also changed in position. Only on the nature of the exudate the rays give no information, as the atomic weight of the constituents do not vary enough to affect the density of the shadow.

Therefore the most careful physical and radiographic examination does not indicate the character of the fluid. Baccelli's sign, that on auscultation the whispering voice can be clearly heard through a serous effusion and not through a purulent one,

is of some value, but not constantly so. Also the history of the disease and the course of the fever only give probable indications which frequently fail.

The only sure information on this point is given by puncture. It is a procedure without danger, but not entirely without drawbacks. Exploratory puncture should be reserved for those cases in which the nature of the effusion is in question. Haemophilia, or a suspicion of bronchiectasis, or of abscess or gangrene of the lung are contra-indications.

The technique of the exploratory puncture is as follows. The syringe should contain 3 to 50 c.c., and have a polished piston; it should be all of glass and capable of being boiled. The needle should be at least 2½ in. long, which is long enough to enter the cavity at any point of the chest wall; its lumen should be at least 1½ mm., so as to allow thick pus to be withdrawn. The ordinary hypodermic syringe is in no way suitable.

Before use the syringe is to be boiled and treated with 1 per cent. carbolic acid solution. The point of puncture depends on the position of the effusion. It is best done below and behind in the right or ninth intercostal space in the scapular line; the thickness of the chest wall here in adults is about 1½ in. If the puncture is made more in the axillary line it must not be below the seventh space. If one chooses the sixth space in the mid-axillary line the wall is only about ½ in. thick. The puncture must be made at the upper edge of a rib to avoid injury to the intercostal vessels.

After the place has been chosen the skin must be disinfected with two applications of tincture of iodine, fixed with the left forefinger, also treated with iodine, and anaesthetized with ethylchloride or injection of novocain. The needle is then quickly inserted in a horizontal direction for about ½ in., and then more slowly advanced till the resistance suddenly ceases and the point is felt to be free in the pleural cavity. The piston is to be slowly withdrawn till the syringe is full of the fluid; the needle is then quickly withdrawn, and the puncture closed with strapping or collodion. If the skin is slightly displaced before the puncture the hole will be more readily closed.

Failure may occur from introducing the needle not deep enough or too deeply; in the latter case there may be some blood-stained expectoration or some frothy blood in the syringe. If the diaphragm lies high it, or the liver, or the spleen, may be wounded. Success may be impossible on account of the needle entering an old adhesion, or being blocked with masses of fibrin or gelatinous exudate. In all such cases the needle may be moved forwards or backwards or reintroduced at another spot, if the assumption of an effusion is well founded.

Bad effects from a puncture are very rare. Infection of the pleural cavity can be always prevented by proper precautions; so can also entry of air. The intercostal nerve and artery can always be avoided by proper technique. Puncture of the diaphragm, liver, or spleen, has usually no bad consequences; neither has entry into lung, if there are no suppurative or gangrenous processes. In nervous, over-excitable, or cardiac patients, it is always advisable to make the puncture painless, preferably by an injection of novocain.

The fluid obtained by puncture tells us if the effusion is

serous or purulent, or whether it is clear, thick, hemorrhagic, or bad-smelling. A specific gravity below 1.015 is in favour of a passive transudation. A microscopic examination gives evidence of the presence of formed elements or bacteria.

The bacteriological examination of the fluid is important. Apart from hydro- and hemothorax we must separate from tubercular pleural effusions those due to pneumonia, rheumatic and traumatic conditions, and staphylococcal, streptococcal, and streptococcal empyemata. In the majority of cases a careful physical examination will reveal the origin of the effusion, while a complete inquiry into the history of the case may show if it is tubercular. However, there are always some cases in which there is nothing to show the nature of the pleurisy, and in which other diagnostic aids are necessary. So that we are brought back to the further examination of the fluid withdrawn.

Stained preparations of the centrifugized deposit hardly ever give positive information in serous effusions, and in purulent exudations tubercle bacilli cannot regularly be discovered. By the use of the antiformin method on the one hand, and of Much's modification of Gram's method of staining on the other, positive results are obtained more often. Still at present bacteriological examination usually fails with serous effusions.

Animal experiment may be employed in the form of intraperitoneal injection of the fluid into guinea-pigs. The method is not absolutely certain, and takes at least three to four weeks to give a result; but at the same time it is the best method we have. To exclude error 20 to 30 c.c. of the effusion should be removed from the pleural cavity and 10 c.c. injected into the peritoneal cavity of two or three guinea-pigs.

Of new methods of the examination of tubercular and other pleural fluids we may mention the microscopy of Jousset. In order to facilitate the recognition of the bacilli in the exudate it aims at setting them free from the clot so that they may be centrifugized to the bottom.

100 c.c. of the withdrawn fluid is allowed to stand till the fibrin clots form spontaneously. This is washed with water, and digested with the following fluid: Potash 1, glycerine 10, hydrochloric acid 10, fluoride of sodium 2, distilled water 1,000 parts. The mixture is placed in a thermostat for 2 to 4 hours at 35° C., or heated in a water bath for a short time at 50° C. The digested mass is then centrifugized and the sediment examined. By this method Jousset found in twenty-three cases of pleural effusion, of which seventeen were not tubercular clinically, tubercle bacilli twenty-three times. It has rarely failed as in several cases tried.

Wolff-Eisner first described, and Widal has especially confirmed, a form of cyto diagnosis, by estimating the proportion of

lymphocytes in the leucocytic contents of the effused fluid. If the lymphocytes preponderate it is in favour of tuberculosis; if the polymuclear leucocytes, then a non-tubercular septic inflammation is more probable. The observations of many authors show that 50 per cent. and more lymphocytes in the fluid make the presence of tuberculosis probable but not certain.

The fluid removed with aseptic precautions is centrifugalized, and the sediment is placed on an object-glass fixed and stained for a quarter of a minute with Loefler's methylene-blue.

Testing for tubercular empyema with Millon's reagent has given us no good results.

The subcutaneous tuberculin test is contra-indicated in pleurisy with effusion as long as there is any fever. Also after the fever has gone the tuberculin test is not always quite definite, since the focal reaction can hardly be detected in the presence of effusion or pleural thickening, and a general reaction may be caused by another tubercular focus in the body, e.g., in the tracheobronchial glands, that has nothing to do with producing the pleurisy.

Prognosis. Miliary tuberculosis has an unfavourable prognosis. Dry tubercular pleurisy usually

runs a favourable course. The fibrinous exudation becomes reabsorbed, or organized, or produces adhesions of the pleural surfaces. Darkenings and thickenings of the pleura are signs of commencing healing. Less favourable are the cases in which an eruption of tubercles occurs in the pleura over a pulmonary focus. The advance of the original disease makes improvement or cure unlikely. Sometimes a pleural fistula with pneumothorax is produced, or there may be an outbreak of miliary tuberculosis. More frequently dry pleurisy is the forerunner of an effusion. The observation of Kossers is important, that in cases of dry "idiopathic" pleurisy more than 40 per cent. were attacked later by pulmonary tuberculosis, usually in the first five years after the pleurisy.

In cases of tubercular pleural effusion the clear serous and sero-fibrinous forms are considerably more favourable than the purulent, and the non-hæmorrhagic than the sanguineous, supposing that the original pulmonary tuberculosis to be in the same stage in each case. In cases of serous and sero-fibrinous pleurisy of a tubercular nature healing of the latent or initial pulmonary tuberculosis with recovery of the strength can usually be completely secured by suitable treatment. There can to-day be no more doubt that the occurrence of a pleural effusion has a favourable effect on the mischief in the lung, taking one case with

another, and not only so in advanced cases, but also in the frequent cases in which pleural effusion appears in the initial stages of pulmonary tuberculosis. The compression and immobilization of the lung by the effused fluid give a strong impetus towards an improvement of many of the symptoms. This is particularly so if the lung on the non-affected side is quite sound, or almost so, while on the side of the effusion there is considerable disease. It is on this that the treatment by the formation of an artificial pneumothorax is based. But it is certain that it is not only the compression and immobilization of the lung which give the impetus towards healing; for the real initial pleurisy, in contradistinction to the pleural complications of advanced phthisis, even if there is only slight effusion, runs a favourable course with great regularity. Besides the mechanical effects of the effusion there are also the chemical influence of the pleural reaction and lymphocytic reaction to be taken into account. Königcr correctly considers that the cases of pleurisy are the most favourable in which the pleural symptoms predominate, and distinguishes, according to the state of the temperature, between the cases of simple pleurisy and atypical forms, in which other tubercular processes, especially in the lungs, are a prominent feature. The first characterized by fairly continuous fever, regularly falling by lysis, is the more favourable pleuritic form; while the atypical cases of unfavourable prognosis are marked by irregular, intermittent fever, which falls slowly with a long sub-fibrile period, and are accompanied by marked sweating, prostrations, and other complications, especially the appearance of tubercular foci elsewhere. In severe cases of bilateral pulmonary tuberculosis the appearance of pleurisy is an unfavourable sign, but not always so even then.

Other important points in the prognosis are the general state of the constitution, the treatment that is employed, and the kind of life that the patient is to lead afterwards. Allard followed up 200 cases of pleurisy, some as long as twenty-eight years after recovery, and observed that those who had a good fresh colour had a better prognosis than those who were pale, even if the pallor was associated with good muscles or corpulency. In a large proportion of cases tuberculosis appears on the same side as the pleurisy. It is important that patients with pleural effusion of tubercular origin should remain under treatment till both the pleural and lung symptoms have disappeared. The patient recovered from a pleural effusion should be treated according to Penzoldt "as a lung case with latent tuberculosis." It would then be more rare for tubercular symptoms in one form or another to appear years after recovery from pleurisy. There can be no

doubt that the prognosis of tubercular pleurisy also depends on the social conditions of the patient, just as it does in pulmonary tuberculosis.

The prognosis of tubercular empyema is much worse than that of serous effusion. It depends on the nature of the lung condition causing the empyema, and also on timely operative interference. In favourable cases healing may take place within four to six weeks, but it may also require many months. If operative measures are not employed at the right time the empyema may break through into the lung or exteriorly, and the prognosis becomes worse. Incomplete healing and formation of a fistula is usually followed by amyloid degeneration of the organs.

Treatment.

The foundation of all treatment of pleurisy must be the general constitutional measures which have already been described in the chapter on Pulmonary Tubercle. They are also demanded for prophylactic reasons, since the treatment of the pleurisy will at the same time be conducive of healing of the primary lung mischief. Only after such a course of treatment can it be expected that the lungs will remain healthy; so that in the course all such measures must be included as are required both for the pleurisy and for the conditions in the lungs which cause it.

Treatment is useless for miliary tuberculosis of the pleura.

Medical aid is often not demanded for dry tubercular pleurisy. If it is it will be on account of the stabbing pain, or irritating cough. Both require bodily rest, best taken in bed either lying on the back or sitting up. If the pains are slight, and there is no fever, and the other conditions are good, the open-air cure may be employed, all movement being forbidden. The patient must be kept in as complete a state of rest as possible, so as to diminish all mechanical irritation of the pleura; he requires careful attention and nursing under favourable hygienic conditions.

The rest will be assisted by a band of strapping 4 or 5 in. broad on the affected side. In order to limit the movements of the chest wall as much as possible it must be firmly applied during expiration, and must reach from the sternum to the spine. One may also employ several narrower straps overlapping each other, as recommended by Nielner. Compression by a bandage is of no service; it must either be fixed too firmly, or it slips away from the seat of pain. The strapping may cause eczema if the skin is sensitive; and its removal is disagreeable if there are many hairs. Kuhn's method of producing rest by fixing the arm is very useful; the arm of the affected side is fixed by bandaging the wrist with

a soft flannel bandage to the upper part of the thigh of the opposite side, which is slightly flexed. When the thigh is stretched out the arm will draw the shoulder down; the patient must lie rather on the affected side, so that the arm presses against the thoracic and abdominal walls, and considerably diminishes the movement of the chest wall and diaphragm on that side. Packing the affected side with sand-bags may also be used to diminish the movement.

Moist compresses may be also applied to the affected side; they will both diminish the movement, loosen the expectoration, soothe the cough, and the nervous system, and promote reabsorption. Their action may be increased by the addition of alcohol. If there is marked dyspnoea compresses must not be used, as removing and changing them increases the difficulty of breathing. Hot fomentations, which are easy to renew, and often do good by producing hyperæmia, may be then employed. In the same way electric baths and hot air baths act. For severe pains an ice-bag often gives the quickest relief. Neither hot fomentations nor ice-bags are useful in all cases; the reaction of the patient varies so much, that if no good is derived from one, the doctor may change to the other.

As counter-irritants to the skin there are special applications which may be employed, especially painting with tincture of iodine, with iodoform-collodion (1 in 10), with guaiacol tincture of iodine (guaiacol 5 parts, tinct. iod. and glycerine 52.25 parts), mustard leaves and mustard plasters. For slight ambulant cases we recommend rubbing with *rad. vasogen*, painting the painful area with oil of turpentine, and afterwards covering it with gutta-percha tissue, or, where obtainable, dry-cupping. To promote absorption ointments may be rubbed in, especially hydrarg. ammon., potas. iodid. and guaiacol salicylate (10 per cent.). We do not value ointments highly for this purpose, and prefer to promote absorption of pleural exudates by the daily use of hot-air baths.

Diaphoretic measures, such as drinking hot fluids, hot baths, and hot packs are almost entirely unsuitable for tubercular forms of pleurisy. Short radiant heat or hot-air baths may often be employed with good results.

For internal treatment sodium salicylate in doses up to 90 gr. a day is to be highly recommended for the acute pains of dry tubercular pleurisy. Salicylates in smaller doses of 8 gr. a day, with or without iodides, may be given for long periods. Finkler has observed diminution and disappearance of the dulness and friction during its use. In the frequent cases in which the stomach does not support sodium salicylate well we order salipyrin (15 gr.

a day) or Dover's powder (4 gr.) for diminishing the pains, and dionin or codein for the cough. We have often observed marked improvement after an undisturbed night's rest; and as an inflamed organ must have all the rest possible we often combine a moist compress at night with dionin drops, or a morphia belladonna suppository ($\frac{1}{6}$ to $\frac{1}{4}$ gr. of each). An injection of morphia or pantopon may be reserved for very restless cases with severe pain.

Respiratory gymnastics with an apparatus or by methodical breathing exercises are best entirely omitted. As an acute progressive pulmonary or pleural tuberculosis may be beginning under the guise of a pleural inflammation, the greatest care is necessary. Only when it is certain that the pleural condition has come to a standstill may light chest massage, lung gymnastics, or inhalation of compressed air be employed with the greatest caution.

In cases in which dry pleurisy lasts a long time, and returns with more or less acute relapses, the question of introducing nitrogen gas may be considered, and we shall allude to it under the head of pleural effusions. As it both relieves the pains and prevents adhesions it has distinct advantages, and is not to be underrated. In conclusion an after-treatment in the high mountains is to be recommended for those cases in which it is possible.

The treatment of tubercular pleural effusions is more complicated. On the one hand the collection of fluid indicates a greater danger of tuberculosis; on the other hand the treatment must partly depend on the amount of the pulmonary disease, on the general condition of the patient, or the state of the heart, &c.

The measures recommended for dry pleurisy are all serviceable for cases with effusion. Rest in bed is more absolutely indicated; even when pains and fever are absent it is required to save the work of the heart as much as possible. If there is dyspnoea the back must be raised, and the patient allowed to remain in the most comfortable position.

A large quantity of fluid in the diet is to be forbidden. Milk, on account of its slightly diuretic action, is the most useful drink. Salt foods are also diuretic; by a continual ingestion of large quantities of salt the fluids of the body are diminished, and the absorption of the pleural effusion stimulated; but this method of treatment is very lengthy and little employed. The food must be concentrated and easily digestible, and is best given in small and frequent quantities.

The value of treatment by drugs is contested; in any case it is uncertain and not to be depended on. Drastic purgatives are

contra-indicated. Constipation may be overcome with saline purges, which at the same time have a diuretic effect. Diaphoretics are useless; antipyretics and narcotics can usually be dispensed with. Sodium salicylate, salipyrin and aspirin may be employed in those cases, and in the largest doses possible, and also preparations of digitalis, with or without diuretin, liq. sod. acetal., or other diuretics.

By these means, in cases where the pleura is capable of reabsorption, a diminution of the effusion can usually be obtained. But when the pleura is extensively affected internal treatment will altogether fail; as we can neither know, nor foresee, the condition of the pleura, these measures may be tried.

In serous and serofibrinous effusions drawing off the fluid by means of a puncture must be considered. This procedure holds its place in the treatment of tubercular effusions. But the views have altered considerably as to the indications and time for using this method; also as to the amount of fluid to be withdrawn, and the advantages and disadvantages compared with other methods of removing the fluid. This can be understood when one thinks of the many different anatomical and clinical forms of pleural tuberculosis. No general rules can be laid down, as one case differs from another. We will content ourselves with giving an outline of the principles which experience has taught us, without going into details.

The indications given by Trousseau for aspirating pleural effusions were: (1) Those endangering the life of the patient; (2) very large effusions; (3) moderate effusions that show no tendency to absorption. The question is how far these indications, which generally hold good even to-day, are applicable to tubercular effusions.

There is not the slightest doubt that tubercular effusions must be punctured if there is unmistakable danger to life from dyspnoea, cyanosis, or heart weakness. Very acute cases of pleurisy due to tuberculosis are scarcely ever met with. But it is common enough in cases of advanced pulmonary tuberculosis for even a slow and moderate effusion to be directly dangerous to life. Also in quite slight lung mischief a very large effusion, which causes dulness of the whole, or nearly the whole, of the anterior chest wall may cause vital danger from its amount, as it may in a non-tubercular person. If, for example, on tuberculosis of the left upper lobe and the right apex a very large right-sided effusion supervenes, there will be only the left lower lobe unaffected, and that is diminished in size from displacement of the heart. So that in cases of threatened danger to life, and in very large tubercular

effusions, the indications for puncture remain unaltered; but only a definite diminution of the effusion must be aimed at, and not more than $1\frac{1}{2}$ to $3\frac{1}{2}$ pints in general removed. It is now agreed that large aspirations in cases of open, progressive, pulmonary tuberculosis are quite contra-indicated.

There remains the third indication to be considered, whether tubercular effusions of medium size, which show no, or only a slight, tendency to absorption should be punctured. Further questions are how long the spontaneous absorption should be waited for, whether the drawing off the fluid is as advantageous as the irritation of the pleura by a simple puncture, whether puncture should be performed during fever, or whether the fall of temperature should be awaited, &c. Experience shows that in cases of tubercular pleurisy, if the puncture is performed during the period of acute inflammation, the fluid returns very often or very quickly. This is not a matter of indifference, but an obvious drain on the constitution of the tubercular patient. The disadvantage of allowing the lung to be compressed for a long time does not apply to a tubercular lung, as it does to a sound one. On the contrary, it is certain that the rest afforded to a tubercular lung from the presence of an effusion in the great proportion of cases makes the course of the pulmonary disease more favourable.

Thus a too early puncture may both be disadvantageous in itself, and a long wait may have a good effect on the tubercular lung from compression and immobilization. On these grounds we would defer the puncture of a moderate tubercular effusion till the fever has disappeared, or is lessening. This usually occurs from the end of the second to the beginning of the fourth week of the illness. This time also seems to be most favourable, as then the cells of the effusion consist only of leucocytes. We thus recommend neither early puncture before the second week, nor late puncture after the fifth; the latter is useless or even disadvantageous. The old maxim, that it was better to aspirate too soon than too late, is of no value nowadays for the treatment of tubercular effusions.

The third indication of Trousseau must be now read, that moderate effusions are to be punctured if there is no sign of commencing absorption after the fever has fallen. With slight disease of the lung aspiration of a small quantity of fluid in the second week of the illness will stimulate absorption. In more severe cases of pulmonary tuberculosis in which cicatricial contraction and fibrous thickening are rather to be desired than feared, since they hinder the action of the diseased lung for a longer period, puncture in the fifth week, or a slow reabsorption, is better than too early interference.

All the same these rules must be taken with a grain of salt. Apart from the fact that the nature of the effusion may alter, a change for the worse in the general condition, or in the state of the lung, due to the presence of the effusion, may demand an earlier puncture, in spite of the presence of fever. It will be then not seldom seen that the effusion does not return, and that the fever either at once or slowly falls, and a sudden change is made for the better. This more often occurs with true initial pleurisy, rather than in cases in which it accompanies advanced or rapidly progressing pulmonary tuberculosis. The more the case appears clinically as simple pleurisy, that is the more it takes the form of an idiopathic disease appearing suddenly in a healthy person, the sooner the aspiration can and must be made, and the more fluid, from 2 to $\frac{3}{4}$ pints, may be removed.

The technique of the aspiration is on the whole the same as that of the diagnostic puncture; we refer to what was said on this subject before, and merely add that the doctor may use the instrument to which he is accustomed. A simple syphon with india-rubber tubing can be used in combination with Fraentzel's trocar, or a two-way trocar of Stimizing or Fiedler. A simple aspiration syringe containing more than 100 c.c. may be employed, or an aspiration syringe with a two-way stop-cock. The complicated apparatus of Potain and Dieulafoy act by exhausting the air, but the simple instrument of Furbringer, in which syphonage is started by the mouth, is sufficient.

The apparatus is not the important thing, but the proper use of it, and the observation of certain rules in drawing off the fluid. This must be in every case preceded by a diagnostic puncture. The pleural cavity must be securely shut off from the outer air during the procedure. For a serous effusion a simple syphon is sufficient, such as is formed by hanging from a cannula india-rubber tubing about a yard long, which dips into a vessel containing water on the floor. Sero-fibrinous and odd thickened effusions cannot be removed without aspiration. Caution must be employed, and the aspiration must not be forcible or active. It should be done slowly, so that the removal of fluid, which should not exceed $\frac{3}{4}$ pints, takes about half-an-hour. If violent cough, dyspnoea, marked cyanosis, or pains in the chest make their appearance, the aspiration must be at once stopped. If that is not done sooner or later after the puncture albuginous expectoration may occur; it is brought up with strong attacks of coughing in the form of a mucoid serum, slightly tinged with blood, often to the amount of several pints.

Effusions transpiration occurs in consequence of great and rapid alteration of pressure in the pleural cavity (from the puncture); this brings about a rapid expansion of the lung, with over-distension of the blood-vessels and a consequent transudation into the alveoli. Effusions on the other side, adhesions, rigidity of the diaphragm, and abnormal size of the heart, are predisposing factors, and may combine to a fatal issue in weakly patients.

To obtain information as to the pressure conditions in the pleural cavity a glass tube may be fixed in the syphon apparatus. If this is held at the level of the site of puncture, the height of the fluid in it will show if there is positive or negative pressure in the pleural cavity. There is also no great difficulty in accurately measuring the intrapleural pressure by means of a manometer, which gives valuable information as to whether the needle has entered the fluid, or whether it must be pushed further in. After the puncture the patient must be kept absolutely quiet; an ice-bag or morphia may be ordered.

In spite of all care there may be bad results from the puncture. Syncope, convulsions, hysterical and epileptic attacks, and paralytic symptoms have been observed. Sudden death from heart paralysis, anæmia of the brain, thrombosis, and embolism has occurred. It must be said, however, that such events are very rare, and may occur in cases of pleural effusion without any interference. The fear of this must in no way dissuade the doctor from undertaking a necessary aspiration. Very cachectic tubercular patients require special care, especially in not removing too much fluid at one sitting. Nervous, highly irritable patients may be soothed by a preliminary injection of morphia; excitable persons may be controlled by hand.

Instead of puncture and aspiration French writers have proposed to blow out the pleural effusion. The procedure consists in filling the pleural cavity during the puncture with sterile air or nitrogen, so that the lung only expands very slowly. It has been tried by many, including ourselves, and has been on the whole successful.

The method described by Holmström is as follows: A hollow needle is introduced into the tenth intercostal space and its outer fluid removed as well as its inner contents. A truss is then introduced into the eighth or ninth space, and through this, with a two-way stop-cock, air is blown in. Owing to the pressure of the entering air large pleural effusions can be entirely removed without danger, as the lung is hindered from rapid expansion. After the fluid is entirely removed either the greater part of the air can be allowed to escape, or the compression on the lung may be maintained, the amount of air to be retained being determined by a manometer. In any case the air will diminish the tendency to adhesions and pleural thickening.

Arndtberger recommends an early puncture in uncomplicated cases of serous or sero-fibrinous effusions; the whole effusion is to be cautiously withdrawn as far as possible, and nitrogen, best from soda gas, carefully blown in. This will prevent the contact of the inflamed pleural

surfaces, and the formation of adhesions, and will allow the later expansion of the lung to take place more rapidly on account of the lessened pleural changes.

The technique in Wenckebach's chair is very simple, and can be carried out with Potain's apparatus. After the fluid is removed the stylet is withdrawn from the cannula, a sterile pad of cotton wool is placed near the opening, and through this air allowed to enter. Nitrogen is only necessary if a longer compression of the lung is required. In general, it may be recommended to introduce only a volume of air or nitrogen equal to half that of the fluid removed; since it is possible that a fresh effusion may take place which, combined with the gas, would produce too great compression of the lung.

The advantage of the use of air or nitrogen over simple puncture is that the symptoms due to too rapid expansion of the lung (cough, pain in the chest, albuminous expectoration, injury to the lung, hæmorrhage, collapse) are avoided. More than the traditional three pints of fluid may be withdrawn; even the whole effusion may be removed. The puncture, also, need not be delayed beyond the third or fourth week, so that the duration of the illness is shortened. The formation of adhesions is hindered. Lastly, there need not be the same fear of unfavourable influencing a primary tuberculosis of the underlying lung by drawing off the fluid.

Puncture may be also necessary for hæmorrhagic, or old serous and sero-fibrinous, effusions. Hæmorrhagic effusions, which are not particularly common in tuberculosis, have a great tendency to return quickly. It is therefore best to postpone the puncture as long as possible, and to limit the amount withdrawn to 100 to 300 c.c. If there are respiratory or cardiac difficulties, only so much fluid need be withdrawn as to give relief to the patient.

Old serous and sero-fibrinous tubercular effusions are very difficult to draw off, since the fluid is very thick, and generally only under slight, or even negative, pressure. Aspiration must therefore be employed for them; in preference to doing too much at one sitting, the puncture may be repeated. As adhesions and loculations have often formed, puncture at different places will be necessary.

Bilateral effusions may require repeated punctures; but sometimes they do not, as on the withdrawal of one effusion the other may become spontaneously absorbed. In all these cases of hæmorrhagic, old, or bilateral effusions we should *now* combine the puncture with the introduction of gas, especially nitrogen. If in spite of this combined procedure the serous or sero-fibrinous effusion frequently returns, washing out the pleural cavity with sterile fluid, or making an opening into the pleura, may be considered.

The frequent occurrence of rapid absorption of a serous effusion after a diagnostic puncture has led to the recommendation to draw off only a small quantity (5 to 10 c.c.) at first, and then to wait and see if the opening up of the lymphatic spaces by the lowered pressure may not result in absorption. If this is not the case the second puncture can be done on the usual lines. We have not seen the lauded results in cases of tubercular effusions. Guilbert and Félde have introduced the modification of systematically withdrawing every day, or every other day, 5 to 10 c.c. of fluid, and then injecting it under the skin without completely taking out the needle; there should then be an extremely rapid absorption. It is very difficult to form an opinion on this procedure, which is called auto-sero-therapy. Some authors give it the first place in the treatment of serous pleurisy, both as regards efficacy and freedom from danger; but by others it is strongly condemned, as they consider that it causes considerable elevations of temperature and other bad results. Brodowsky observed good results from repeated puncture, without the subsequent injection of the aspirated fluid. If the effect is produced by the repeated mechanical irritation of the puncture, which gives a reflex stimulus to the pleura towards reabsorption, then it is a matter of indifference whether 10 c.c. or only 1 c.c. are withdrawn each time, and whether the fluid is afterwards injected subcutaneously or not. We ourselves have observed no good effect from withdrawing a small quantity of fluid at one puncture, followed by a second, with injection of the fluid; neither have we observed in recent cases of serous effusion the above-mentioned bad results, which are difficult to explain.

The treatment of cases of tubercular serous pleurisy after the effusion has been drawn off must be different from that of the non-tubercular cases. While in the latter all must be done to produce as far as possible a *resilatio ad integrum*, and an expansion of the compressed lung, even to the breaking down of adhesions, in tubercular cases these things must not be aimed at, and adhesions and thickening of the pleura must be even counted on. If they occur, they must remain; *quies non movere*. Therefore no pneumatic treatment must be employed. In these cases we should limit ourselves to the exercises and respiratory movements warmly recommended by Hoffbauer and Escherich, which consist of making the patient sleep on the affected side at night, and several times during the day breathe for some minutes through the nose, while the trunk is bent to the sound side. In conclusion, the after-treatment of pleurisy, as long as the pulmonary tuberculosis is not healed, consists really in the treatment of the latter condition.

For the removal of pleural adhesions, which are causing contraction of the lung and mechanical displacement of the heart, Rothschild and Mendel have found good results from thiosinamin. It can be obtained in the form of fibrolysin in sterile ampullae containing 50 minims (Merck); the subcutaneous and intramuscular injections are absolutely painless and produce no cicatricial tissue. Three hours after the injection respiratory exercises should be begun. The therapeutic results are diminution of the thickenings, and improvement in the subjective symptoms. We have in several cases seen no result. The indications for its use also are limited. While Schüttgen considers quite recent cases as suitable, Rothschild excludes patients in bed, and those with fever, from the fibrolysin treatment.

The specific treatment of tubercular pleurisy goes together with that of the lungs; there is no information on this subject in the literature. So long as dry pleurisy is accompanied by severe pains, or serious cases with high fever, tuberculin treatment is out of place. Generally it should be reserved for the after-treatment.

For the treatment of tubercular purulent pleurisy, puncture with introduction of gas or washing out with fluid, syphon drainage of Bülau, and thoracotomy, especially with resection of rib, have been recommended.

The radical operation of thoracotomy with resection of rib takes the first place, as it allows the removal of the purulent exudate to the last drops. But it has the great objection that it entails a pneumothorax, and therefore those parts of the lung, which are still capable of respiration, become collapsed. This is particularly serious if the other lung is extensively tubercular. It accounts for the bad results and often rapid aggravation, which may be observed after thoracotomy for tubercular empyema. The views as to the expediency of the operation for tubercular empyema are still at variance. Some are opposed to the operation on principle, others only if the pulmonary tuberculosis is advanced. Bäumer allows an operation as soon as pus-producing organisms are found in the exudate. Gerhardt, Stintzing and Laveran recommend the operation if the tuberculosis has lasted a long time and is not yet extensive. It may be remarked that the surgeons now hardly recommend thoracocentesis with rib-resection; it may be reserved for special cases, e.g., small loculated empyemas. R. Frank voices our opinion very exactly when he says that the removal of a piece of one rib has no effect in diminishing the size of the thorax, and is not necessary for emptying and draining the cavity. An empyema can usually

be without objection emptied by means of Bülow's drainage; if it fails, or if it seems from the first that it will be insufficient, as in cases of chronic thickened empyema, then thoracotomy, with removal of part of one rib, will also be insufficient, and a thoracoplastic operation with extensive rib resection will be required. We agree that this latter operation may be indicated, but only when the milder measures have failed.

Bülow's siphon drainage avoids producing a pneumothorax. Its object is, without making a communication between the pleural cavity and the outer air, to lower the pressure in the pleural cavity by continuous aspiration, and thus in favour the re-expansion of the lung, and at the same time to maintain a continuous inflow for the pus. The method consists of introducing a tube into the pleural cavity without permitting entry of air, and fixing to this tube a siphon apparatus.

According to Bülow, the instruments required are: (1) A trocar of about 5 mm. bore; (2) a Jansen's catheter, which just fits in the cannula; (3) foot-let of india-rubber tubing with a small weight at the end; (4) a glass tube of the length of a finger rather inserted at one end, to make the junction between the catheter and the rubber tubing; (5) two clips; (6) a small funnel for filling the siphon apparatus; (7) some dressing, bandages, and strapping. According to Frank, (1), (3), (4) are better replaced by one piece of drainage tube, strong enough and smooth enough to pass through the trocar. The tube should be over a yard long, and its thoracic end should be rounded off and cut obliquely, 1 cm. from this end should be a large oval drum-hole.

The technique of the operation is as follows: The skin is prepared with iodine, and anaesthetised, together with the deeper parts, by injections of novocain and suprarenin. The skin having been opened with a short incision, the trocar is plunged into the pleural cavity, the needle withdrawn, and the catheter or drainage tube quickly passed down the cannula. The latter is then withdrawn over the catheter, which now alone, to the extent of some 41 cm., passes through the chest wall. It must be first clamped, and then carefully fastened to the chest wall. The union is now made between the catheter and the tube filled with liquid, and the clamps removed. The pus now slowly flows into the vessel on the floor, while the lung should expand.

The puncture may be made in the scapular line in the eighth to tenth space, or the posterior axillary line in the eighth, in the mid-axilla in seventh or eighth, and in the anterior axillary line in the fifth to seventh; the lowest point possible is to be generally chosen. The trocar is to be passed over the upper border of a rib, and the sudden cessation of resistance, which marks the entry into the pleura, must be looked for. The method of fastening the drain-tube to the thorax is very important. On both sides of the opening silk sutures are passed through the skin; these are knotted, and tied round the drain. For further security these are fixed to the catheter by wrapping round both a small band of strapping, which later may be further fastened to bands of strapping on the chest wall. By this means the drainage may remain undisturbed for two to four weeks.

The vessel containing the fluid, of which Bülow has invented a special form, may be fastened beside the bed in such a position that there is a difference of not more than half a yard between the levels of the point of puncture and the fluid in the vessel.

The flow of pus should not go on continuously. After the puncture only about 500 c.c. are to be at first removed; if attacks of coughing come on the flow must be stopped with the clamp. Every two to three hours the

Chamber may be opened and about 200 c.c. allowed to flow, till the empyema is nearly empty. Then, for the first time, the tube may remain open.

The most important parts of the after-treatment are maintaining a secure fixation of the drain, and attending to the overflow vessel. A change in the drain-tube during the whole treatment is not to be made, and is not necessary. During the first fourteen days the drain must under no conditions be allowed to come out, or to be pulled out during sleep; after that there is, as a rule, no difficulty in re-introducing it, as the passage is lined with granulations. When, after six to eight weeks, the daily amount of pus has fallen below 50 c.c. the vessel may be drained and the drainage-tube cut short, and later replaced by a smaller one, the discharge being received into a small dressing. The fistula is usually completely closed after some months. If after six to eight weeks there is still much discharge, it is not likely that healing can be secured by simple puncture. If the tube becomes blocked it can usually be cleared by coughing, or by lowering the receiving vessel. Attempts at washing out usually do more harm than good.

The drawbacks of the method are the possibility of the catheter slipping out, and the tedious watching and after-treatment required; sometimes the tube becomes blocked, the fistula enlarges, the temperature rises, &c. Therefore the treatment requires to be carried out in a hospital. Syphon drainage only answers in recent cases, in which there are no adhesions, and when the lung is still capable of re-expansion. Therefore its use for tubercular empyemas is decidedly limited. On the other hand, it presents great advantages, particularly the simplicity of the operation, without narcotics or an open wound, the avoidance of pneumothorax, and the encouragement to re-expansion of the lung. Weighing these considerations, syphon drainage has the advantage over the radical operation, which can be done if the former fails, or is not indicated.

Lately Erhard Schmidt has specially recommended the combination of syphon drainage and aspiration for the treatment of tubercular empyema. By this means blocking of the drainage tube is obviated, and since an increased negative pressure is maintained continuously in the empyema cavity, there is an increased favourable action on the collapsed lung, and a hyperæmic state of the pleura and lung is produced.

For this method a flask, partly filled with sublimate solution, lined with a three-way stop-cock, is necessary. One way communicates with the drainage-tube, another with an air-pump, and to the third a manometer is attached. The pleural cavity is subjected to the negative pressure daily; in the intervals the vessel is disconnected, and the patient can move about.

Puncture, followed by washing out the pleural cavity, does not remove all the pus, or prevent it from reforming, even when as wide a trocar as possible is used for the aspiration and lavage. The method is so far palliative, as it greatly diminishes the quantity of the exudation, and therefore the pressure on the lung and the pains felt by the patient. Also by washing out with

a solution of salicylic acid (1 in 1,000) the pus is made thinner, and a certain amount of antiseptic effect produced.

For this an aspiration syringe, containing 200 to 300 c.c., must be fixed to a trocar with a stop-cock. The pus must be gradually withdrawn, without great alterations of pressure. The stop-cock is then shut, the syringe removed, emptied of pus, and refilled with the fluid at the body temperature. This is then carefully injected into the pleural cavity and withdrawn again; the process being repeated as required.

By this proceeding one can succeed in making the pus much thinner, and in washing out the pleural cavity by degrees. Bad results are possible, but not probable if care is taken not to introduce more fluid than the volume of pus withdrawn; so that no great alteration of pressure should be caused. But both the aspiration of the pus and the introduction of the salicylic acid solution must be done slowly, and with the greatest caution.

Finkler has made it possible to combine the method of puncture and washing out with a measurement of the pressure; by which means it may be seen if the pus can be allowed to flow out rather quicker, and thereby exert some force of expansion on the lung.

Puncture with simultaneous introduction of air, as has been recommended for sero-fibrinous effusions, has been used, according to Forlanini and Wenckebach, also for tubercular empyemas with good result. In this case a larger trocar must be used, and it must be directed as deeply as possible into the pleural cavity, so that all the pus that can be is removed. The action of the air in blowing out the thick pus can be aided by first introducing salt solution under a measured pressure. Wenckebach has seen after repeated filling with air definite healing of chronic tubercular empyemas. The absorption of the air introduced produces a negative pressure in the pleural cavity, which favours the re-expansion of the lung. When this seems a particularly important point, the re-filling may be done with a gas more quickly absorbed, e.g., oxygen. Air, however, is always and everywhere at our disposal, and makes the formation of an artificial pneumothorax in cases of tubercular empyemas a simple matter, and produces no deformity on healing, as do extensive surgical measures.

Therefore the treatment of tubercular purulent effusions must not be so much a matter of rule as it has been. There are various suitable measures, which must be practically considered, if the tuberculosis has not advanced too far in the lungs, and if the pus is detected in time. As methods of choice we recommend for general use repeated withdrawal of the pus with simultaneous introduction of air, and puncture combined with washing out

under measured pressure; sometimes a combination of both methods.

2. TUBERCULAR PNEUMOTHORAX.

Anatomical Changes.

By far the most frequent anatomical cause of pneumothorax is pulmonary tuberculosis. According to Rose 86 per cent., and to Gerhardt 90 per cent., of all pneumothorax cases are of tubercular origin. It is brought about usually by an ulcerating cavity in the lung, sometimes by slighter tubercular changes, reaching the pulmonary pleura, and incidentally breaking through. Through the fistula thus formed between the lung and the pleura air enters the pleural cavity, while the lung on account of its elasticity contracts. If adhesions exist between the lung and the chest wall the pneumothorax is partial; on the other hand in cases of total or free pneumothorax the whole side is full of air, and the lung becomes completely atelectatic.

If the perforation becomes closed by lymph and by the collapse of the lung tissues, a closed pneumothorax is produced, which diminishes as the air is reabsorbed. If the opening has stiff walls, even when the lung is collapsed, the opening between the bronchus and the pleura remains patent. The pressure is then equalized, and the pneumothorax is open.

If the pleural fistula is only closed on expiration, with each inspiration air will enter the cavity, without being able to escape on expiration, and we have the valvular or pressure form of pneumothorax, which is that most commonly produced by, and most characteristic of, tubercular disease. The stronger the inspirations are the more air will pass through the valve, till the pressure in the pleural cavity becomes positive. Even then strong coughing movements force more air into the pneumothorax, which produces complete collapse of the lung on the affected side. The combination of the considerably increased positive pressure on the diseased side, with elastic retraction of the sound side, produces marked displacement of neighbouring organs, and difficulty of expiration.

The air passing through the tubercular lung carries moulds and pathogenic organisms into the pleura. The contents of the cavity, containing tubercle and other bacilli, also enter the pleura. The never-failing result is the formation of a serous, or more often of a purulent, effusion in the form of a sero- or pyo-pneumothorax. The former may remain as such, or may become changed later into the purulent variety.

Symptoms and Course.

In advanced phthisis, which has produced extensive pleural adhesions, pneumothorax may occur unrecognized, and remain long without causing any special symptoms, so that it is first discovered at the autopsy.

But the clinical symptoms of pneumothorax are usually of an alarming nature. After the feeling of an internal laceration, severe pains, oppression, breathlessness, and cyanosis appear. The pulse is small and much accelerated; and collapse with cold sweats may occur.

The further clinical condition depends on the form of the pleural fistula. The objective and subjective symptoms depend on the amount and pressure of the air in the pleural cavity, which are greatest in the valvular form of pneumothorax. The difficulty of breathing may take the form of orthopnea. The patient lies on the useless side, so as to make the greatest use possible of the sound one. The affected half of the thorax is markedly distended, and the intercostal spaces are filled up. The displacement of the mediastinum and heart to the sound side, and the diaphragm downwards, is very considerable. The pressure on the heart and large vessels causes marked cyanosis; and on the first day there may even be general dropsy.

The percussion note is abnormally loud and deep, and in open pneumothorax tympanic. Pleximeter percussion gives a metallic clang. The breath sounds are suppressed, or of a weak bronchial or amphoric character. Often metallic tinkling sounds, and the noise of falling drops, are to be heard. Vocal fremitus is weak or absent, according to the amount of air and degree of compression. The temperature is quite irregular.

Sero- and pyo-pneumothorax cannot be distinguished from each other by the symptoms. Both cause moderate or high fever with marked remissions; both increase the intrapleural pressure, and therefore the pains. Over the lower parts there is dulness, the limits of which are easily altered on change of position. On shaking the patient a succussion sound, and on sitting him up a deeper percussion note than when lying (Biemer's change of note) may be detected.

A tubercular pneumothorax may pursue a chronic or a very rapid course. A valvular pneumothorax may cause death in a few hours. This occurs especially in young individuals, since in them, owing to the elasticity of the chest wall, the bad effects of the increased pressure and displacement of the organs are more rapidly and severely felt (pneumothorax acutissimus). In opposition to this there is the spontaneous-tubercular pneumothorax,

which forms quite gradually, and may last for years without producing effusion or fever.

Diagnosis.

The diagnosis of tubercular pneumothorax is usually made without difficulty from the characteristic subjective points and the objective signs; frequently the condition can be recognized in a moment. Also its cause, on account of the advanced tubercular lung changes, is usually fairly obvious. Only the circumscribed partial pneumothorax can possibly be confused with a large cavity. Also a small pneumothorax may be difficult to recognize if it occurs in an atypical situation, or if it contains merely the scanty remains of what was once a large quantity of air.

In all cases the Röntgen rays may be of diagnostic value in several ways. We may mention that owing to the displacement of the lung the rib shadows appear unusually clear; the shadow of the compressed retracted lung can be seen at the hilus; bands may be seen passing between the lung and the costal pleura, or the dome of the diaphragm; and the characteristic displacements of the neighbouring organs will be obvious, due more to the elastic pull of the other lung than to direct pressure of the escaped air. In sero- or pyo-pneumothorax there can be clearly seen the sharp horizontal upper limit between the air and the fluid, which moves with each pulsation of the heart, or change of position of the patient. Also at the upper limit of the effusion can be seen a distinct respiratory rise and fall, the shadow rising with inspiration and falling with expiration; this is the phenomenon of the paradoxical diaphragmatic movement. When the differential diagnosis of pneumothorax from large cavities is in question illumination must be tried both from behind, from before, and in an oblique direction.

The further important diagnostic point whether the effusion is serous or purulent must be settled by an exploratory puncture. This may give rise to subcutaneous emphysema, from letting the air through the costal pleura, or to infection of the needle track in cases of pyo-pneumothorax. The temperature gives but very uncertain indication as to the nature of the fluid.

Prognosis.

According to the observations of L. Spengler, Rose, Unverricht, and others the prognosis of pneumothorax cannot now be considered as quite hopeless. Spontaneous healing has even been observed. All the same the mortality is somewhere about 80 per cent. According to the figures of West quite a large proportion die in the first twenty-four hours, and 60 per cent. in the first month after the occurrence of the pneumothorax.

In the first place the extent of the pulmonary disease must be considered in forming the prognosis of an individual case. Advanced, bilateral disease makes the outlook very black, while unilateral disease, even if extensive, may be favourably rather than unfavourably influenced by the occurrence of a pneumothorax on that side.

Also the prognosis depends on the form of the pneumothorax. If the condition of the lung is approximately the same, the following differences may be drawn. A closed pneumothorax runs usually a better course than an open one, and an open one better than the valvular variety, which claims the most victims during the first few days. The very rare pneumothorax without effusion gives the best chance of recovery; next a partial one with an effusion. The uncommon sero-pneumothorax seems to recover with more difficulty than the purulent form, which is more immediately dangerous to life, but the after recovery from which is no more unlikely.

The form of treatment to be employed is also important for prognosis. A therapeutic nihilism of an expectant character is usually synonymous with a more or less rapid fatal ending.

Treatment.

In the treatment of tubercular pneumothorax the general constitutional measures, above all the careful and skilful nursing of the patient, are so important a factor that hospital treatment seems indicated. But the removal must be delayed till it can be done without doing harm. Heart weakness and collapse usually occur at the commencement; they must be met by suitable stimulants (camphor, ether, digitalis, caffeine, champagne, cognac, coffee). The further treatment depends on the form of the pneumothorax.

In cases of valvular pneumothorax, which is clinically the most important form, it is of prime importance to diminish the difficulty of breathing, and to avoid attacks of coughing. These ends are best obtained by a morphia injection ($\frac{1}{4}$ gr.), which may be repeated if necessary. Bands of strapping are a support.

If these measures do not bring about sufficient improvement, according to the advice of Unverricht, there must be no delay in making a wide thoracic fistula. This fistula must remain constantly open, so as to produce an open pneumothorax, and to prevent a rise of pressure in the pleural cavity. This is the essential principle of the measure proposed by Unverricht. The opening must be so arranged that it is not blocked in any part of the respiratory phase, thus obviating entirely the results of raised pressure.

The technique of this very simple method is described by Unverricht as follows: An incision is made between the ribs and the largest possible drainage-tube introduced. At the outer end of the tube is fixed a wire cap, which is covered with a dressing and bandage, so as to receive any secretion there may be, but not to hinder the free communication with the outer air. A thin layer of gauze will not prevent this, while it will act as a filter for bacteria, and obviate the infection of the pleural contents.

Unverricht has obtained by this method complete healing of tubercular pneumothorax. There is, of course, the possibility of bacteria entering the open pleural wound and producing septic infection, but this may be neglected, as even then the course of healing is not hindered.

Puncture, aspiration, and syphon drainage have no place in the treatment of valvular pneumothorax, as they produce only a temporary lowering of the pressure, prevent the spontaneous closure of the pulmonary fistula, and may even cause it to reopen when it has closed.

In cases of closed pneumothorax without effusion, or only quite a small one, no operative interference is required. The reabsorption of the air may be awaited with antiphlogistic measures and morphia injections.

Cases of sero-pneumothorax may at first be treated on expectant lines, when fever and threatening symptoms are absent, and the effusion is only large enough to compress the lung in an advantageous way. If improvement and reabsorption of the effusion and air do not occur, then puncture with washing out the pleural cavity, or replacement of the fluid by nitrogen, may be considered. The technique of these methods has already been described.

For the treatment of pyo-pneumothorax there is a choice between introduction of air or nitrogen, puncture with washing out the cavity, thoracotomy, or thoracoplastic operation. The condition of the patient must govern the choice of the method. If the general condition is bad, the pulmonary disease advanced, and the heart does not admit of operative interference, then the milder means must be employed, especially one of the two first mentioned. On the other hand, if the general condition is good, and if septic changes have taken place, then thoracotomy with rib resection is the rational treatment. It sometimes gives surprising results, especially if the other side is but little diseased, or practically sound. But not uncommonly a fistula and purulent discharge remain after the operation; but this possibility should not prevent the operation being undertaken. If it is not done, secondary abscesses, spontaneous discharge of pus, internal fistula, and other incurable complications will occur, which should be prevented at all costs. Thoracoplasty must be reserved for a

last resort for ill and total pyo-pneumothorax, in which there is a large purulent cavity. Also a fistula remaining after thoracotomy may require a radical plastic operation.

It has been recently recommended that a direct attack should be made on the lesion causing the tubercular pyo-pneumothorax, and that the pulmonary fistula should be closed by suture, Sauerbruch's differential pressure apparatus being used. Particularly encouraging results have not yet been obtained.

The after-treatment of tubercular pneumothorax must be on the same lines as that for tubercular pleural effusions.

CHAPTER IV.

Tuberculosis of the Upper Air Passages.

THE nose and the naso-pharynx perform the functions of warming the entering air, of saturating it with moisture, and of freeing it from dust, so as to avoid as far as possible injurious effects to the lower air passages from cold, dry or contaminated air. It is obvious that a permanent defect of physiological nasal breathing must have a prejudicial influence on healthy lungs, which becomes more marked if they are diseased. Krönig's apical induration (p. 81) may be mentioned here, and also the extreme view which ascribes the formation of the phthisical chest to hypertrophy of the pharyngeal tonsil. Although the latter theory will not stand a scientific test, it must be admitted that chronic obstruction to nasal breathing during youth may unfavourably influence the development of the thorax, and therefore of the thoracic organs. Careful attention to the state of the nose and naso-pharynx is thus required, not only with those already suffering from tuberculosis, but for prophylactic reasons, especially with those of an hereditary tendency and scrofulous and otherwise predisposed persons.

Nasal polypi must be removed, hypertrophies of the turbinates diminished by amputation or the cautery, and slighter cases treated by the bloodless method of fracture and dislocation (Killian). If there is hindrance to the entry of air from inspiratory sucking in of the nostrils, Feldhaus's or some other dilators should be worn. Large spines and crests of the septum should be removed submucously; marked deviations of the septum should be submitted to the window-flap resection under local anaesthesia; in slighter cases according to Killian breaking the nasal septum, and also one or both turbinates is sufficient. These operations, however, should be only done in cases of

tuberculosis, especially if the disease is open, when they are absolutely necessary; if possible they should be postponed. We disagree with those enthusiasts who attack with hammer and chisel every deviation and spine of the septum in tubercular patients.

In advanced hypertrophy of the pharyngeal tonsil, and also in cases of adenoid vegetations, we recommend removal of the obstructions, as they are a fertile source of recurrent catarrhs, and thus have a prejudicial effect on pulmonary tuberculosis; also they may become primarily or secondarily infected. The existence of tuberculosis of the lung is only a contra-indication if it is far advanced or complicated.

The pathological changes that have been mentioned, by producing chronic obstruction to nasal breathing, lead to drying of the mucous membrane, and thereby to chronic catarrh of the throat and larynx. This is the more unfortunate for the tubercular patient, as he has already a tendency to chronic inflammation of the upper air passages. A repetition of such catarrhs may set up a persistent irritating cough, and the catarrh may descend into the lower tubes, and by lowering the resistance of the healthy epithelium give an impetus to the spread of the tubercular disease. From this point of view the non-tubercular affections of the upper air passages in phthisical patients demand careful attention; we will discuss the most common varieties in a few words.

In the first place acute catarrh of the nose, throat, and larynx in cases of active pulmonary tuberculosis must always be regarded as a serious complication. An attempt must be made to prevent the spread to the lower air passages by means of general treatment, such as rest in bed, with a uniform temperature of the room, promotion of perspiration by tepid packs, antipyretics, diaphoretic and diuretic drinks, and mineral waters, and possibly incandescent light baths. For the local treatment of cold in the head we recommend with Spiess the early and repeated applications of anesthesin or orthoform. Also cocaine in the form of a spray, a tampon, or the insufflation recommended by Turban of cocaine 1, morphia .4, and boracic acid 10 to 10 parts, has given us very good results. Patients are less willing to submit to Bier's congestion, produced by an india-rubber band round the neck, which is a good treatment for all cases of inflammation of the upper air passages. In acute catarrh of the throat we have had the best results from painting with 10 per cent. silver nitrate once a day for several successive days, a gargle of salt solution being used directly afterwards to neutralize the excess. Ephraim recommends painting with antipyrin, quinine bichlor., and aq. dest.; after two to three applications of this the throat is

sufficiently anæsthetic to permit painless galvano-cauterization. Less prompt are the effects of astringents like acetic acid, potassium chlorate, tannin, alum, iodine, &c. In acute laryngitis good results are obtained by inhalation of volatile oils (best 10 per cent. menthol oil), of 1-2 per cent. tannin solution, and of weak salt solution, combined with alcoholic compresses. Blumenfeld recommends insufflations of calomel as the best local abortive treatment. In cases with a tendency to colds and chills the prevention must be carefully considered.

Hypertrophic catarrh of the nose and throat requires local treatment. In acute cases the above-mentioned astringent powders and solutions, perhaps combined with sedatives, may be used. Painting with Mandl's solution (iodine 1, pot. iodide 5, glycerine 25 parts) is to be specially recommended. Washing out the nose and naso-pharynx has been deprecated on account of the danger of injury to the epithelium; in open tuberculosis a tubercular infection of the middle ear is also to be feared. Chronic partial, or diffuse, swellings of the mucous membrane may be treated by the galvano-cautery, or by removal. We may mention that for these small operations Ephraim recommends submucous injections of 2 per cent. solution of antipyrin as being superior to cocaine, novocain, and alypin in quickness and duration of action, in its capacity for being kept and sterilized, in being completely non-poisonous, and in its price. We prefer the galvano-cautery to cauterization with chromic acid. In severe cases more or less prolonged relief may be given to the obstructed breathing by massage of the hypertrophied turbinate, or better by painting with 5-10 per cent. cocaine solution. The hypertrophied follicles in granular pharyngitis are a frequent cause of cough irritation. They seem to be not uncommonly of a tubercular nature (Sokołowski). Painting with .5 per cent. silver nitrate solution or 20 per cent. menthol oil may relieve the symptoms. A more radical treatment is to seek for the painful and irritable spots in the fauces with a probe, and then to destroy them with tri-chlor-acetic acid, or to burn them with a pointed galvano-cautery so superficially that there is no injurious scar formation.

Atrophic catarrh of the upper air passages or xerosis has a still closer connection with tuberculosis, since on account of the degenerative changes of the mucous membrane and the damage to the epithelium the powers of natural resistance are lost, and tubercle bacilli and other infectious organisms can more easily penetrate into the deeper air passages. Thus *ozæna* is of importance both for the prevention and treatment of tuberculosis.

The very effective treatment of *ozena* by means of Goststein's tampons, which are soaked in various drugs (balsam of Peru, ichthyol, hydrogen peroxide), is to be little recommended in tuberculosis, on account of the prolonged obstruction to nasal breathing involved. The application of electrolysis requires special instruments, as does vibration massage of the mucous membrane, whilst ordinary massage is difficult and tedious. We have found nasal douches of 2 per cent. guaiacum oil solution to be a very easy and successful mode of treatment. Also the powdered snuff (iodol crystals, tannic acid, and borax equal parts) used five or six times a day, recommended by Turban, has given us good results. In cases of marked atrophy of the turbinates it is advisable to insert small tampons as protection against dust and cold; for this purpose Sprenger's porous india-rubber pellets, provided with an india-rubber thread, seem to us to be practical and easy to use. Dry pharyngitis requires care and the exclusion of external injurious agencies. The most appropriate treatment is painting with Mandl's iodo-glycerine solution once or twice a week. Gargles of olive oil or weak salt solution with a little glycerine are useful; bedridden patients especially derive benefit from these mild measures.

Catarrh of the larynx will be more fully considered with the diagnosis of laryngeal tuberculosis. For its treatment the astringent and sedative measures there given are applicable.

L TUBERCULOSIS OF THE NOSE.

Anatomical Changes.

Tuberculosis of the nose most often takes the form of a solitary ulcer, which is usually situated on the anterior cartilaginous part of the septum. The ulcer is generally small, round, and superficial, has a characteristically indented edge, and a dirty rough base. Near to the edges, which are studded with small red granulations, typical nodules may be seen.

The tubercular tumour is more rare, and is nearly always also localized on the cartilaginous septum. It forms a broad tumour, seldom projecting much, of very various appearance; it may be smooth, rough, or nodular, of a pale to dark red colour; the consistence may be soft or hard. The size usually varies between a small pea and a hazel-nut. Only very rarely have larger tumours been described. The tuberculous soon destroys the cartilage, and grows in a similar way in the mucous membrane of the opposite side. The mucosa over it may remain unaltered, or more frequently becomes ulcerated. Later the tumour necroses,

and in favourable cases may entirely disappear, leaving only a perforation.

Diffuse infiltration and a granulating form of nasal tuberculosis have also been distinguished. The diffuse infiltration may also have a granulating surface; it may lead to extensive thickening and destruction of the septum. According to Gerber it is probably a form of primary tubercular perichondritis.

Miliary tuberculosis and primary tuberculosis of the bony framework of the nose are very rare.

Lupus of the nose is difficult to distinguish from tuberculosis clinically. It also has a predilection for the septum, and according to Gerber especially for the anterior angle of the nasal aperture, when it is frequently hidden by what is apparently eczema of the vestibule. The first nodules grow out from the nostril, and affect the exterior part of the nose. In later stages lupus takes the form of circumscribed or diffuse infiltration, and has a tendency to cause perichondritis and perforation. Also the turbinates, especially the lower, may be affected by diffuse lupoid infiltration; it is characteristic of lupus that on the raised surface besides irregular ulcers cicatricial changes are to be found, a combination very rare in tuberculosis.

Symptoms and Course.

The clinical symptoms of nasal tuberculosis, especially at the commencement, are slight and not characteristic. They consist of moderate secretion and obstruction due to swelling or crusts, and depend upon the amount of the disease.

The swelling extends as far as the lower turbinate, and often blocks the nasolachrymal duct, through which the caruncle of the eye may become secondarily affected. Long-standing ulceration of the septum leads to perforation; which is particularly common with tuberculosis. In distinction from the idiopathic form of perforation, which may also be met with in phthisical cases, the edges are usually markedly swollen.

Ulcers of the septum may spread to the upper lip, producing a simple inflammation, a tubercular infection, or scrofulous eczema.

Tuberculosis of the nose is a comparatively rare disease, the conditions for the lodgment of tubercle bacilli being unfavourable owing to the structure of the epithelium, the respiratory air movements, the secretion of nasal mucus, and certain reflex expulsive acts. Primary tuberculosis of the nasal mucosa has certainly been observed, especially in the form of tuberculoma. Usually the infection is secondary, rarely from the conjunctiva, most frequently from sputum from a diseased lung, and probably

sometimes from direct vaccination from an infected finger poked into the nose. Spread of disease to the surrounding bones and cavities is very rare. This form of tubercular disease, which is uncommon, usually begins in the bones themselves, empyema of one of the sinuses being secondary. Lupus of the nasal mucosa very often forms the starting point of lupus of the face, but secondary infection of the nose from outside is also frequently seen.

Diagnosis.

The recognition of most of the secondary affections usually gives no difficulty, especially when the primary disease is obvious. If there is an ulcer in the nose the overlying crusts must be first removed. The characteristic appearance of the ulcer has already been described. If part of the base is removed, tubercle bacilli, frequently in large numbers, can be generally found. If they are absent confusion may be caused with gummatous ulcerations; these, however, are usually situated on the vomer or plate of the ethmoid, and the edges are sharp, hard, and less granulating. They react promptly to iodides. The tuberculoma can hardly be confounded with a malignant tumour, for it seldom exists long by itself alone, and has a great tendency to necrosis. The idiopathic perforation, which according to Sehenmann is the result of anterior rhinitis sicca, has in contrast with the tubercular perforation a smooth edge, while the syphilitic perforation is apt to spread on to the bony part of the septum. In all doubtful cases a microscopic examination of a piece of excised tissue, a local tuberculin reaction, or the result of iodide treatment should clear up the diagnosis.

If the area of disease is sufficiently clearly defined, its radical removal is not difficult. In other cases relapses are the rule. But even then the prognosis is not entirely unfavourable; in any case this must depend chiefly on the nature of the primary disease.

Treatment.

For large ulcers, infiltrations, granulations, and tumours the best treatment is energetic scraping under cocaine, with subsequent cauterization with concentrated lactic acid. As a rule it is necessary to repeat the operation several times, as it is impossible to remove all the disease at once. Chromic acid and tri-chloro-acetic acid are much used as cauterizing agents. Hinsberg recommends the applications of tampons soaked in various concentrations of lactic acid.

Isolated tumours may be removed by the ring curette or by the hot or cold snare, and the base cauterized with the galvanocautery, which also suffices for small ulcers and circumscribed

infiltrations. The after treatment can be carried out with lactic acid or a disinfecting or astringent powder. In healthy patients with perforation caused by a tuberculous Körner recommends excision of the whole of the diseased part of the septum; by which means he has always obtained an easy and lasting cure in two to three weeks.

Tuberculin is warmly recommended by many writers, such as Onodi and Rosenberg.

Lately Pfannenstift has published cases of cure of nasal lupus by internal use of iodide of potassium with inhalations of ozone. In the Finsen's Light Institute Strandberg has confirmed these results, and has simplified the treatment by substituting tampons of 1 to 2 per cent. peroxide of hydrogen for the ozone. Körner is of opinion that the effective part of this treatment is the administration of iodide, which he uses for non-operable cases of diffuse tuberculosis and lupus of the nose and gullet.

Lastly, Nagelschmidt has obtained surprisingly quick results in eight cases of nasal tuberculosis by means of the diathermic treatment, which will be described later in the section on Lupus.

2. TUBERCULOSIS OF THE NASO-PHARYNX.

Anatomical Changes.

Tubercular ulcers, and more rarely tumours, have been met with in the naso-pharynx. According to Moortz Schmidt the tumours usually grow from the back of the velum palatinum, where also tubercular ulcers may be situated, likewise on the pharyngeal tonsil and neighbourhood of the Eustachian tubes. The appearance of both these varieties resembles that described in the previous section. With superficial erosions and ulcerations there are deeper ulcers with a dirty grey base and swollen edges. The tumours are accompanied by a marked hyperplasia of the adenoid tissue, causing much swelling, which has but slight tendency to necrosis; later the tubercular tissue preponderates, in which, however, very few tubercle bacilli can be found.

Tuberculosis of the pharyngeal tonsil is more frequent. It is noticeable that this, like the palatal tonsil, may be affected with tuberculosis without being swollen, or without presenting any naked-eye evidence of tubercle. It is an extremely mild form of the disease, ulceration is very rare. The lymphatic tissue contains tubercles and giant cells to a variable amount. Tubercle bacilli are usually very scanty.

Lupus also may occur in the naso-pharynx, usually in its nodular, infiltrating form; it has a very slow course. It is very

rarely indeed primary, usually being secondary to disease in the anterior part of the nose, in the soft palate, or in the posterior wall of the pharynx. Its favourite sites are, according to Seifert, the posterior edge of the septum, the nasal surface of the uvula, the posterior pharyngeal wall, the orifice of the Eustachian tube, and the pharyngeal vault.

Symptoms and Course.

Tuberculosis of the naso-pharynx is comparatively rarely observed in the living patient, it is usually found after death in cases of phthisis with milary tuberculosis. In fifty phthisical corpses E. Frankel found tubercular ulcers in the naso-pharynx ten times; Dmochowski twenty-one times in sixty-four phthisical bodies, of which eight had milary tuberculosis. Usually the affection is secondary and occurs in the last stage of lung disease; probably it would be more often detected if posterior rhinoscopy could be regularly employed on these exhausted patients. There are no special clinical symptoms. Ulcers on the back of the palate may be recognized by spots of redness on the anterior surface. The lymphatic glands at the angle of the jaw and front of the neck are fairly often affected. Tuberculosis of the pharyngeal tonsil causes the same symptoms as chronic enlargement; cases of primary disease have been described, usually it occurs from infection from sputum.

Diagnosis.

Tubercular ulcers and tumours may be recognized without difficulty with the mirror; but tubercular tumours may, however, be confused with a neoplasm or gumma; in these cases a histological examination must be made. Tuberculosis of the pharyngeal tonsil can only be revealed by the microscope, except perhaps in those rare cases in which there is necrosis and ulceration.

Prognosis and Treatment.

The prospects of cure are conditional on the prognosis of the disease in the lung. If the disease is circumscribed, local treatment as required for nasal tuberculosis may bring about cure. With advanced disease in the lungs the treatment must be purely symptomatic. As tuberculosis of the pharyngeal tonsil is generally not recognized as such the treatment will be that of simple hyperplasia. The fear that after removal there will be frequent relapses has not been confirmed; but there is certainly a possibility of an ulcer forming on the raw surface left. By means of local applications of tuberculin Schnitzler produced destruction of large tubercular tumours in the naso-pharynx, and healing occurred to a large extent, and Trautmann obtained a complete cure by tuberculin injections continued for several months.

3. TUBERCULOSIS OF THE LARYNX.

Anatomical Changes.

According to Moritz Schmidt tuberculosis of the larynx occurs as infiltration, ulceration, tumour or miliary tubercle. Any of these four forms may be present alone, or they may be combined in various ways. Lupus must be separately considered.

Histologically infiltration is marked by considerable thickening of the mucous membrane, affecting equally the mucosa and submucosa, which may become three or four times their normal thickness. The smallest nodules of infiltration appear of the size of a grain of millet or hemp, and are already recognizable with the laryngoscope. The tubercles appear in the mucosa and submucosa, generally in great numbers; they are always at first above the glandular layer, and are embedded in a fine or coarsely reticulated tissue, filled with numerous small round cells. The epithelium remains, till it becomes softened and ulcerated; frequently an outgrowth from the superficial layers occurs, in the form of pendulous, papillomatous excrescences. As the disease advances the glands and vessels become involved, and the tubercles commence to caseate.

To the naked eye the infiltration has a yellow or red colour, and is always more or less oedematous. It may remain for some time in this stage, or may undergo either reabsorption or ulceration. The infiltration of the epiglottis, which seldom occurs without ulceration, may be either localized or may affect one-half or the whole of the cartilage, and causes marked swelling. When the whole edge of the epiglottis is infiltrated the swelling often has the shape of a turban or horse-shoe. As the swelling increases the epiglottis becomes rigid and immovable. Infiltration of the aryteno-epiglottic folds may occur on one or both sides; this also causes much swelling, which may be most marked in the region of Santorini's cartilage. The movements of the folds and of the arylenoid cartilages are always diminished, and in severe cases lost. Infiltration of the posterior wall may occur in several forms, either as a thick, diffuse, velvety softening, as several straight folds, as smooth, uneven, or cleft nodules, which may be sessile or pedunculated, and may project more or less far into the lumen of the larynx. The infiltration may be situated in the middle or side of the posterior wall, or may fill up the whole inter-arytenoid region, and attain such a size that it pushes in between the vocal cords, and prevents the closing of the glottis. Infiltration of the vocal cords may be at first partial on the free edge of one or both sides, particularly in the neigh-

Fig. 1.



Uniform epithelioma of the left vocal cord.

Fig. 2.



Tumor-like induration of the left vocal cord.

Fig. 3.



Induration of the posterior wall in its whole extent.

Fig. 4.



Superficial elevation of free edge of right vocal cord.

Fig. 5.



Commencing ulceration on edges of both cords. Granulations on the posterior wall.

Fig. 6.



Extensive marginal ulceration of left cord. Induration of posterior wall.

Fig. 7.



Superficial ulceration of both cords.

Fig. 8.



Superficial ulceration of posterior wall.

Fig. 9.



Ring abscess.

Fig. 10.



Flattening of the posterior wall (due to atrophy).

Fig. 11.



Papillary outgrowths from the posterior wall, with induration. Elevation of the posterior wall and the cords.

Fig. 12.



Extreme induration. Virtual closure of posterior part of the larynx. Slight swelling of anterior part of the cords.

Fig. 13.



Enlarged irregularity of the epiglottis.

Fig. 14.



Large, fleshy outgrowths of granular tissue (left and right). Congestive irregularity of the epiglottis.

Fig. 15.



Elevation of the posterior wall of the larynx and the cords.

Fig. 16.



Thickening of the aryepiglottic cartilage.

Fig. 17.



Partial detachment of the right part of the thyroid cartilage, moved to the left side.

Fig. 18.



Swelling of the lower part of the pharynx and entrance to the larynx.

hourhood of the *processus vocalis*, which may become red, hemispherical, or slightly indented, or ragged and often resembling a papilloma (Schech). Circumscribed infiltration in the anterior angle of the glottis is considerably more rare, but according to Jurasz, in the absence of other changes, it is a very suspicious symptom. It is generally smooth, and situated either exactly at the angle of the glottis, or just above or below it; it lasts a long time without breaking down. With total infiltration the vocal cord has a cylindrical shape; it may attain the thickness of a pencil, so that it is difficult to distinguish the true and false cord; generally, however, a fine dark line marks the junction of the two and the entrance into the ventricle (M. Schmidt). Infiltration of the false vocal cord, often accompanied by ulceration in the ventricle, produces a round or oval swelling, generally uneven on the surface; it is nearly always diffuse. The swelling may be considerable, and may fill the whole *sinus Morgagni*, and completely cover the vocal cord. When the infiltration is bilateral both cords may be hidden, and only a narrow, irregular cleft seen between the swollen false cords. The formation of tubercles in the false cords is usually very excessive; the prominent areas, according to Schech, consist of a conglomeration of tubercles. Infiltration of the mucous membrane of the ventricle assumes a special form, which may be mistaken for a prolapse of the mucosa. The comparatively rare subglottic infiltrations appear as light or deep red, elongated glands parallel to the vocal cords on one or both sides, more seldom in the form of a ring; they may reach a considerable size.

Tuberculosis of the mucous membrane is not the only cause of infiltration at entrance of the larynx; it may be produced also by perichondritis.

The tubercular ulcer of the larynx arises from an infiltration by softening of a superficial deposit of tubercle, and necrosis of the epithelium. The size and depth of the ulcer is very varied; the more superficial occur in the region of the squamous epithelium, the deeper in the cylindrical epithelium, especially where the glands are plentiful (Biefel). Sometimes there is only a sieve-like appearance of the mucous membrane. Necrosis of superficial infiltrations gives rise to a more or less extensive superficial ulceration which is characterized by a grey, or dirty yellow, spotted base, and irregularly indented, often swollen and undermined, edges. Deep infiltrations reaching to the glands produce very serrated, crater-like ulcers, which may extend to the muscles or the perichondrium. All forms of ulcers may be covered with a very exuberant growth of granulations. They may become

secondarily infected with other bacteria, especially streptococci and staphylococci.

Ulcers of the epiglottis are usually situated on the lower side, and accompany infiltrations; more rarely they occur on the edges, usually as a consequence of perichondritis. If the ulcers are deep, necrosis and loss of substance of parts of the epiglottis ensue, leaving notches. In the region of the arytenoid cartilage and aryteno-epiglottic folds ulcers are only found in the later stages, either on the top of Santorini's cartilage, or along the whole length of the fold, even entering the sinus piriformis. On the posterior wall ulcers have a special tendency to develop, and are often the first sign of laryngeal tuberculosis; in advanced cases they may cover the whole posterior wall, and cause confusion with papilloma on account of the oedematous granulations. If the ulcers are superficial the posterior wall may appear jagged, or eroded into clefts or furrows; if they are due to necrosis of deeper infiltrations the posterior wall is irregularly fissured, and contains crater-like depressions with steep, granulating edges. If the vocal cord is affected, single or numerous ulcers appear on its surface, surrounded by infiltrated tissue and granulations; later they become confluent, and an elongated ulcer may form along the free edge, or on the under side. These long ulcers have at first a serrated, jagged, or nodular appearance, and later increasing infiltration of the cord develops, in which the opposite healthy cord lies, as Moritz Schmidt says, like a knife in its sheath; the edges are often studded with granulations, which may reach a fairly large size, and considerably obstruct the glottis. Even if the outer edge of the cord is also ulcerated there may still remain a raised band of non-ulcerated tissue in the middle. If the ulcers spread on the lower side of the cord, there will be swelling in the subglottic region, and the ulcers may extend on to either the posterior or anterior wall below the glottis. An ulcer is very likely to form on the processus vocalis, generally as the result of necrosis of an infiltration, more rarely from infection of a small wound. It forms a gutter-shaped depression, with a yellow base, and abrupt edges. According to Jurasz these ulcers have a regular, triangular shape, keeping strictly to the outline of the cartilage. They easily cause perichondritis of the arytenoid cartilage, since it is here very superficial and the submucous tissue poorly developed. The swellings of the false cords also frequently form ulcers, which may be either superficial, causing pitted or sieve-like depressions in the mucous membrane, or deep in the form of more typical tubercular ulcers. In many cases the granulations are so luxuriant that the false cord is converted into a raspberry-like mass (Schoch).

In autopsies on advanced cases of phthisis the lowest part of the larynx is not uncommonly found to be ulcerated. Subglottic infiltrations usually break down late, and then produce a ring ulcer surrounding the whole glottis, or a mass of granulations causing obstruction.

The tubercular tumour is histologically quite identical with infiltration, only it is less oedematous; no sharp line of division can be drawn between the two; but the infiltration is diffuse, and the tumour more circumscribed. The tumour may form by itself or in combination with other tubercular changes; it is not often primary. Outwardly the tumour resembles a fibroma or papilloma. Its size varies between that of a lentil and a cherry; in its growth it is extremely slow. It is generally round or hemispherical, more rarely lobulated. Its surface may be either smooth and shining, or uneven and nodular. The colour varies between white, grey and red. It very rarely appears on the epiglottis, if it does it is usually on the under side near the petiolus. On the vocal cord it usually necroses; probably the cases that have been described are rather outgrowths of granulations on the base of a more or less healed ulcer. The most frequent site is the sinus Morgagni and the false cord, where it can best be observed.

The military form of laryngeal tuberculosis is a fairly rare disease. It occurs first on the epiglottis, the false cords, the posterior wall and the subglottic region. The granules are rarely observed, because they are either very quickly absorbed or necrose rapidly, forming a large ulcer. In general military tuberculosis the appearance of grey granulations on the larynx, for instance, on the cords and epiglottis, has undoubtedly been observed.

Perichondritis is rarely primary, but is usually secondary to advanced disease of the mucous membrane. Septic organisms reach the perichondrium from the neighbouring ulcer and by setting up inflammation prepare the way for tuberculosis. On account of the purulent inflammation the perichondrium becomes loosened from the cartilage, which dies and is partly or entirely thrown off. In rare cases the pus may break through the mucous membrane internally, or externally through the skin. Perichondritis presents the appearance of tubercular infiltration. If the epiglottis is affected there is considerable swelling. As a rule, the edge of the cartilage first becomes bare; as the disease advances the whole epiglottis may be destroyed. Perichondritis of the arytenoids is most often due to ulceration in the region of the vocal cords, as here the cartilage is only separated from the mucosa by scanty submucous tissue. A tense swelling is formed,

which obliterates the contour of the arytenoid, and extends from the inter-arytenoid fold to the posterior part of the aryteno-epiglottic ligament. It encroaches on the lumen of the larynx and hides the posterior part of the cord. Ossification of the cartilage, or inflammation and ankylosis of the arytenoid articulation usually occur early. Ulceration of the posterior wall may also lead to purulent inflammation of the arytenoid cartilage, which may spread to the plate of the cricoid, and produce subglottic swelling. Here also abscess formation and exfoliation of part of the cricoid may occur (Scherch). Perichondritis of the thyroid cartilage often spreads through the cartilage from inside to the outside, and causes a rounded swelling, which can easily be felt through the skin; it may soften and discharge pus exteriorly.

Killian describes a tubercular, hematogenous infection of the laryngeal framework, which takes the form of perichondritis affecting the thyroid and cricoid cartilages and commencing at the spots where ossification centres form. If tubercle bacilli reach the marrow spaces of the ossification centre with their sluggish circulation, osteomyelitis and perichondritis will be set up. Masses of granular tissue are formed, which caseate and necrose, and sequestra floating in pus may be the result. The mucosa remains for a long time intact, and is only displaced inwardly towards the larynx, giving a characteristic appearance according to the localization of the disease. If the cricoid is affected there will be subglottic swelling; if the mesial part of the thyroid, an internal fistula is formed later with prominent edges, so that externally the disease can hardly be recognized. These are the rare cases of so-called tubercular perichondritis, in which sequestra of the ossified thyroid or cricoid cartilages may be coughed up.

If the tubercular changes are deep the intra-muscular connective tissue is also implicated, leading to waxy degeneration of the muscle, and then to alterations in the movements of the cords and pain on moving and swallowing.

Lupus of the larynx appears most often in the form of nodules and ulcers. In non-ulcerating lupus the mucosa is studded with numerous, rather hard, pinkish spots of the size of a millet grain, which look like granulations. They mostly affect the entrance of the larynx, the much thickened epiglottis and aryteno-epiglottic folds, and the posterior wall. But generally the surface breaks down, so that irregular superficial ulcers are formed, which are distinguished from tubercular ulcers by being surrounded by lupoid nodules, and separated by characteristic scars. The infiltrating form of laryngeal lupus has been more rarely described.

It starts in the much thickened epiglottis and spreads over the aryteno-epiglottic folds to the posterior wall, so that the whole entrance to the larynx presents a red, nodular infiltration, which may lead to considerable narrowing. On the posterior wall more often tumour-like infiltrations appear. When the true and false cords have been long affected with lupus, subglottic infiltrations and ulcers have been often described.

**Symptoms and
Course.**

One of the most common symptoms of laryngeal tuberculosis is alteration of the voice, which may vary between slight thickening of the voice to complete aphonia. But this alteration does not always correspond with the amount of disease. Even with slight ulceration the voice may be considerably affected, and—which is more important—it may hardly suffer at all in advanced disease. For this reason a laryngoscopic examination should be made in all cases of phthisis, and in all patients with the slightest suspicion of change in the voice. Frequently the voice of the phthisical patient is weak, even when the larynx is healthy, on account of general asthenia and weakness of the vocal and respiratory muscles; in the later stages waxy degeneration of the muscles, which has already been mentioned, is a common cause of voice weakness. Paresis, such as feelings of scratching, tickling, stabbing, compression, dryness, or obstruction from mucus, are noticeable quite early, causing a continual need of clearing the throat or coughing. Paresis of the vocal cords may produce hoarseness, which, however, may also be due to chronic pharyngitis. Swelling, nodules, ulceration, inflammation of the cartilage, ankylosis of the joint, alterations of the muscles, or paralysis of the recurrent laryngeal nerve on one or both sides, may all cause various grades of alteration in the voice. With disease of the epiglottis, of the aryteno-epiglottic folds, and circumscribed affections of the false cords and even of the posterior wall, hoarseness may be entirely absent.

Pains in the region of the larynx are also a common symptom; they may be spontaneous or occur on speaking or swallowing; they are due to ulcers, muscular infiltrations, involvement of nerves, perichondritis, &c. Pains on swallowing, which spread to the ear along the auricular branch of the vagus, indicate with fair certainty perichondritis of the arytenoid. Often the pains may be brought on by external palpation of the larynx; fixed painful spots have symptomatic importance.

In advanced laryngeal tuberculosis with much swelling, difficulty of swallowing occurs. Other common causes of this are perichondritis of the epiglottis and arytenoids. The patients

swallow frequently, especially when drinking, which causes much irritable cough; food and drink often come back through the nose. The pain on swallowing often leads to the refusal of food, but only in advanced cases.

The cough is, as a rule, caused by the disease in the lungs. Even severe disease of the larynx does not necessarily cause cough; ulcers on the processes *vocales* generally cause it, as do pendulous granulations on the posterior wall. The cough caused by swallowing has already been mentioned. A very teasing cough may be caused by the exposure of a nerve in the floor of a laryngeal ulcer.

Expectoration, too, mostly comes from the lungs. Laryngeal secretion is generally slight, and rarely indicates the nature of the pathological changes. With extensive ulceration a thin, greyish green, sometimes sanguineous pus is excreted. Malodorous pus is produced by perichondrial abscesses; it may contain necrotic tissue and portions of cartilage. The more advanced is the laryngeal disease, the more copious is the reflex secretion of mucus. Hemorrhages from the larynx are only slight and have no special importance.

The breathing is characteristically affected, if in consequence of much swelling, infiltration or oedema, a greater or less amount of stenosis is produced (laryngeal dyspnoea).

Laryngeal tuberculosis occurs at every age of life; it spares neither early childhood, nor old age; but cases at such extremes are rare. M. Schmidt has seen it in a child of 1 year; Lublinski, Scherh and M. Schmidt have reported cases over 70 years of age. It is most often met in the years between 20 and 40, in which also pulmonary tuberculosis is commonest. Men are affected decidedly more often than the women. The reason for this is probably that the male larynx is more exposed to injurious influences, such as tobacco, alcohol and the mechanical irritation of various occupations, than the female, though this view is not held by all observers. Statements as to the relative frequency of pulmonary and laryngeal tuberculosis are much at variance; this is entirely due to the different material on which they are based (reports from public and private sanatoriums, specialists, pathological anatomists).

That laryngeal tuberculosis can be a primary disease must be admitted by supporters of the theory of infection through the air. Undoubted cases, supported by autopsy, are observed by example by Von Demme, E. Fränkel, Orth. Doubtless a large number of the primary cases that have been reported are due to faulty diagnosis; especially the statements of French authors as to the

frequency of primary laryngeal tuberculosis as a consequence of co-habitation with a tubercular individual, are to be received with caution. Usually the infection occurs secondarily through the sputum. The exhaustive animal experiments of Albrecht have proved with certainty that laryngeal tuberculosis, especially in its typical form, occurs in by far the majority of cases from contact infection with sputum, and that the tubercle bacilli, after injury and loosening of the epithelium, may penetrate into the sub-mucous tissue. The entry of bacilli into spots that have lost their epithelium was also considered by Orth to be the most common mode of infection; other authors believed that they could also penetrate the intact mucous membrane. The danger of infection of the larynx is the greater the more abundant the bacilli are in the sputum, the more frequently the latter is deposited in the larynx, the longer it remains there, and the more the larynx is in a state of irritation and inflammation. Certainly Albrecht has shown that tubercle bacilli carried to the larynx of rabbits in the arterial circulation produce a growth of tubercles in the mucous membrane and muscles. Haematogenous infection is therefore possible; it must, however, only occur in rare, atypical cases. Similarly tubercular disease of neighbouring structures may provide the requisite conditions for lymphatic infection. The fact that laryngeal tuberculosis is most common in far-advanced lung disease, when the laryngeal epithelium is chronically inflamed, loosened and weakened by continual coughing, and perhaps also by the chemical action of the expectoration, is in favour of infection by the sputum. It has been observed often enough that an abrasion of the larynx may become secondarily infected and form a tubercular ulcer, and that at symmetrical points on the cords contact ulcers form (Moritz Schmidt, Fischer), an observation that has been made also by ourselves. That there is a lateral correspondence between the disease in the lung and the larynx has been maintained, but not proved; to us it appears more than improbable.

Blumenfeld's observation that laryngeal tuberculosis as such seems to be inherited in certain families is worthy of notice; it corresponds with the inheritance of a *locus minoris resistentiae* in the lungs described by Turban in cases of phthisis.

The course of the affection varies according to the predominance of the disease in the lungs or larynx. Generally laryngeal disease only develops in severe cases of phthisis, often it first appears in the last act of the drama; then it merely plays a subsidiary part to the lung disease, and the latter has the more rapid progress. The patient dies of exhaustion, or cardiac or pulmonary complications.

Sometimes, however, the laryngeal tuberculosis is the principal disease, the pulmonary symptoms being in the background. Its progress then depends upon its nature and position, and whether cough or breathlessness, pain or difficulty of swallowing are prominent symptoms. The illness may terminate acutely from oedema of the glottis, or the patient may die slowly from exhaustion. It has often been said that laryngeal patients are strikingly tough, and it is remarkable how long they often drag on, in spite of severe symptoms and deficient nourishment.

The symptoms of lupus of the larynx are not different from those produced by the same clinical forms of laryngeal tuberculosis. It is noticeable that pain is almost entirely absent, even in advanced ulceration. Primary lupus of the larynx is rare; as a rule the disease is secondary to lupus of the nose, the throat or the face. Lupus in the larynx, as elsewhere, has a marked tendency to cirrhosis. If it occurs at the entrance of the larynx it may cause marked stenosis. The infiltration leads, usually after a long time, to ulceration and perichondritis, the necrosis produced by the latter being almost confined to the epiglottis.

Diagnosis.

The recognition of the various forms of laryngeal tuberculosis by means of the laryngoscope is easy, therefore the clinical symptoms that have been described have no special importance for diagnosis. With sufficient experience of the instrument even the deeper forms of the disease may be brought into view, perhaps with the assistance of cocaine.

Some practical hints may not be without use here. Large tonsils should be pressed aside with a full-sized mirror; with sensitive patients quite a small mirror may be used. To see beneath a very pendulous or swollen epiglottis, if loud phonation of *ah* is not sufficient, one may stand in front of the sitting patient, or raise the epiglottis by pressure on the thyroid cartilage, or by means of a probe after the use of cocaine. The posterior wall can be seen by the method recommended by Killian, in which the patient stands and bends his head forwards, or the doctor may kneel in front of him. The lateral parts of the larynx, the cords when overhung with swelling of the false cords, and the subglottic region can be better seen if the patient's head is bent laterally, and the mirror placed at the side of the uvula.

The following points may help the avoidance of mistakes. A very pallid condition of the larynx has no importance if it is not in striking contrast with the normal colour of the other mucous membranes. Acute and chronic catarrh in tubercular patients

may cause confusion with tubercular laryngitis on account of the redness and swelling. There is here always a possibility that tubercles may be found in the mucosa or submucosa. A chronic catarrh that resists all treatment is always suspicious of tuberculosis. A diagnostic tuberculin reaction may produce a focal reaction and clear up all doubt. The fear of using tuberculin for an early or differential diagnosis on account of the danger of a focal reaction is not justified; the objective signs of this are usually only redness and swelling, and the subjective symptoms passing pains and disturbance of sensation. A spread of the disease in the larynx or even a necrosis of existing foci is certainly never observed after a diagnostic injection; the dangers are merely theoretical.

Unilateral inflammation of a vocal cord is always very suspicious; syphilis is the only disease that causes it besides tuberculosis.

In phthisical patients catarrh and epithelial necrosis may occur in the vocal cords, and be confused with tuberculosis. The same is true of the erosions and raw areas occurring on the processus vocalis in pachydermia.

Swelling and folds of the mucous membrane of the posterior wall of the larynx in chronic catarrh and pachydermia must not be considered to be tubercular, even if the surface appears softened or covered with secretion, or in pachydermia if it is much swollen and indented. The differential diagnosis from pachydermia is sometimes hardly to be established by the appearance alone; the age and other ætiological factors, such as excess of alcohol or tobacco, chronic catarrh, or overstrain of the voice may decide, but in certain circumstances a microscopical examination will be required. It is useful to paint the suspected part with a cocaine-adrenalin solution, when the tubercular foci often show up distinctly from their pale surroundings.

Moritz Schmidt draws special attention to the fact that sometimes in laryngitis sicca the dry, firmly adherent, mucous crusts can look very like tubercular ulcers. By applying menthol oil or cocaine solution, and then directing the patient to cough, the crusts may be easily removed.

The following criteria are of service in distinguishing between tubercular and syphilitic ulcers. Tubercular ulcers have an irregular, swollen appearance, a dirty spotted base, and soft, flat or raised, undermined edge, on which there are frequently small red granulations. Tertiary syphilitic ulcers, formed from breaking-down gummata, generally lie on a thickened base, and

seem to stand out, their edges are steeper, harder, and have less tendency to granulate; the infiltration is usually much firmer, and the mucosa much reddened. With regard to the situation of the ulcers it is worth noticing that syphilitic ulcers are seldom found on the posterior wall of the larynx, while tubercular ulcers prefer that spot. A tuberculin injection may show the true nature of the ulcer.

In some cases of tubercular ulceration of the larynx tubercle bacilli may be found in the secretion, but not in all. It must be remembered that tuberculosis and syphilis may be combined, and that tubercular sputum may be by chance deposited on a syphilitic ulcer. Superficial cleansing of the larynx by syringing does not guard against such a diagnostic error. On the other hand a syphilitic ulcer can become infected with tuberculosis, so that a mixed form, difficult to recognize, is not so rarely produced.

The diagnosis of syphilis may receive considerable support from a positive Wassermann's reaction; or if after the administration of large doses of iodide (30 to 75 gr. a day) a tendency to healing is distinctly recognizable within fourteen days; only very old cases require longer administration of iodide or the addition of mercury. A therapeutic injection of salvarsan may be used in the same way, if it is not contra-indicated by putrid expectoration from the lung, heart changes, or other reasons. In mixed cases the cure of the ulcer is not complete, and the obstinacy of the parts remaining unhealed indicates the nature of the complication. The diagnosis from the result of treatment is also possible in doubtful cases of gummatous tumour and syphilitic perichondritis. Other syphilitic signs will not be lacking.

Tubercular tumours must be diagnosed from fibroma, papilloma, and, above all, carcinoma. These neoplasms may so closely resemble the primary tubercular tumour that a positive diagnosis is not always possible. Only when cancer is situated on the vocal cord is it quite characteristic and not to be mistaken for tuberculosis. In later stages the difficulty increases from the formation of necrotic ulcers. The greater involvement of one half of the larynx, the preponderance of new formation over ulceration, as well as the hardness and rigidity of the infiltration indicate cancer. In spite of these points there are cases in which the diagnosis can only be firmly established by the course the disease takes, or by microscopical examination of an excised portion of tissue. In rare cases the simultaneous presence in the larynx of tuberculosis and cancer has been noted. Laryngeal

lupus is distinguished in its ulcerous form from tubercular ulcers by the characteristic lupoid nodules which are always present in the neighbourhood, by the spontaneous scarring at various spots, and by the very slight pain produced even by large ulcers. Laryngeal lupus has much in common with syphilis, for example, the scar formation. Confusion can only occur in the rare cases of primary lupus, and then a test tuberculin injection or the result of iodide treatment will help to settle the doubt.

Prognosis.

That laryngeal tuberculosis has no tendency towards spontaneous healing is the opinion of the majority of laryngologists and tuberculosis specialists. The contrary opinion, which was expressed at the last congress of German laryngologists by Dreyfuss, Kummel, and Rumpf, is founded on the observation of recovery in cases of non-specific chronic inflammatory conditions, and so-called catarrhal laryngeal ulcers in phthisical patients. Nevertheless, recovery without artificial help is not so very rare, even with large infiltration and ulceration. According to Killian this occurs chiefly in men whose occupation entails a life in the open air. It also occurs in patients with great natural powers of resistance, in whom the lung disease is also stationary, and who spare themselves and their larynx. There exists an unmistakable connection between pulmonary and laryngeal tuberculosis in regard to prognosis, and the former being the chief and fundamental disease, determines the whole prognosis. In accordance with this we see a relapse of the laryngeal disease accompanying activity of pulmonary tuberculosis. Certainly there are exceptional cases in which in spite of advance of the disease in the lungs the laryngeal tuberculosis becomes arrested or even cured, and the reverse may occur. The prognosis is bad if the mischief in both lung and larynx is advanced, and it is the more favourable the less severely the lungs are diseased, and the more localized the laryngeal affection. Fever, continued loss of appetite, severe pains which prevent the taking of food, perichondritis, and pregnancy are the most important complications which impair the prognosis. Hereditary tuberculosis, according to Thost, Schech, and others, is less favourable, acquired disease more so. According to v. Baumgarten tubercles formed entirely of lymph-cells are the richest in tubercle bacilli and the most unfavourable, those formed of mixture of lymphoid and epithelioid tissues are poorer in bacilli and run a middle course, while those formed purely, or almost so, of epithelioid or giant cells contain the fewest bacilli, and offer the best prognosis (Schech).

With the advances of laryngology and surgical treatment, the use of the galvano-cautery, and the modern application of specific treatment, the prognosis of laryngeal tuberculosis has improved as much as that of lung disease; but here, as in every form of tuberculosis, the important point is the earliest possible recognition and treatment of the disease.

The prognosis of lupus of the larynx is bad if the disease is extensive. The prospects of a local cure are considerably better in circumscribed forms, especially as they are generally situated at the entrance of the larynx, and so are easily accessible for local treatment.

Treatment.

Since 1880 a reaction has set in against the fatalistic conception of the incurability of laryngeal tuberculosis, which has put an end to therapeutic nihilism. Much of the merit for this belongs to Moritz Schmidt, Heryng, and Krause. During this time the treatment has undergone many changes, and even now opinions as to the relative efficacy of, and the indications for, the different methods are at variance. It is obvious that the same method cannot give the same results in all cases; but the various lines of treatment may be so combined as to obtain many satisfactory results in cases not too far advanced. Much depends on the selection of the method most suitable to each individual case. But all measures must be applied with careful consideration of the disease in the lung and its prognosis. One should refrain from surgical treatment if the patient can receive no lasting benefit in spite of a good result from the operation. For this reason the patient must be first carefully observed and treated with all the general means at our disposal, until the prognosis with respect to the lung disease can be considered as hopeful. As a preliminary to all surgical operations the disease in the lungs must have become at least stationary, the general health improved, the body-weight increased, and the temperature nearly normal. Other cases call for conservative treatment, unless an operation is necessary to save life, or to relieve dysphagia.

The local treatment may be medical, surgical, or physical. Of medical agents menthol is probably most used. It has a slight astringent, anæsthetic, and vaso-constrictor effect, and exerts a favourable influence on specific and non-specific congestion, swelling, catarrh, and superficial ulcers. Menthol oil (10 to 20 per cent.) may be dropped into the larynx, or it may be given by inhalation. A simple form of the latter is to pour some of the menthol oil on to boiling water, the steam to be inhaled through a funnel. As the hot menthol steam sometimes causes irritation

it is better to vapourize the menthol into the room by means of Frankel's inhaler. B. Frankel himself has obtained very good results from its use, in advanced cases, and considers that if it is employed for a long time the number of operations required will be diminished, but our experience has not been so good. The simplest, cheapest, and most generally applicable method of diminishing the secretion, irritation, and cough is Hartmann's inhalation mask, which has given us the best results.

The wire-work of the mask, which can be obtained in a form something like a spectacle frame, is painted with a mixture of equal parts menthol and ether. After the latter has evaporated the former remains in the meshes of the wire netting in a more solid form and lasts for one or two days. The duration of the inhalation and the amount of menthol used vary with the needs of the patient; the mask can be worn during work, and even during the night. By means of the mask prolonged inhalation of balsams for the treatment of bronchitis and bronchiectasis can also be carried out. Hartmann recommends for cases of phthisis with much secretion a mixture of eucalypti $\frac{1}{2}$ of menthol in parts 10 to alternate with the menthol.

We have used the mask as a protection after laryngeal operations and to intercept the spray caused by severe coughs with much fluid secretion.

Coryfin is recommended by many authors as a substitute for menthol. Its utility has been proved, but not its superiority over menthol, which still probably enjoys the greater popularity.

Use may also be made of balsamic inhalations (balsam of Peru, oil of turpentine, and eucalyptus, &c.), and of sprays of borax (2-4 per cent.), boric or lactic acids, tannin (1-2 per cent.), alum, &c. They act by cleansing the larynx and loosening the secretion. That freeing the mucosa from the tenacious, irritating secretion brings relief to the cough is shown by the widespread use of inhalations of mineral waters, such as Ems, and of weak bicarbonate of soda, and common salt solutions. The inhalation should take place with superficial breathing, the tongue being depressed or extended. The inhalers and spraying apparatus most in use have already been mentioned in the section on the Treatment of Pulmonary Tuberculosis; we consider Spiess's apparatus to be the best and simplest.

Of disinfectants and astringents in the form of powder there are iodoform, aristol, thioform, pyroctanin, isosphen, &c., either alone or mixed with boracic acid. Killian considers iodoform the most useful powder, and the least injurious to the appetite. All these measures have only a superficial action and serve to cleanse ulcers, lessen secretion, stimulate granulations, and prevent mixed infection. Superficial ulcers may thus be cured, but deeper ones seldom. The powders are gently blown into the larynx by means of an insufflator, the most suitable being those of M. Schmidt and Hartmann with changeable glass mouthpieces.

To alleviate pain, and especially difficulty of swallowing caused by extensive infiltration and perichondritis, anaesthetics are required. Cocaine (5-20 per cent.) is always useful in solution or in powder mixed with boric acid. Newer substitutes avoid the toxic symptoms sometimes caused by cocaine, but their effect is not so intense; we prefer alypin, with or without suprarenin. A weaker, but more durable, anaesthesia is obtained by blowing on anaesthesin, orthoform, propasin, and cycloform; the latter has been well recommended, especially when combined with euryfin. The prolonged use of an ice-bag is at times very effective. Even in severe cases of dysphagia much relief may be given by C. Spengler's liquor anaestheticus, a 5 per cent. alcoholic solution of anaesthesin, in combination with iodine or aromatic substances. The patient may himself paint the throat with it, or it may be used as a spray. Recently R. Hoffmann has recommended the injection of 1 to 2 c.c. of 85 per cent. alcohol warmed to 45° C. into the neck, at the point where the inner branch of the superior laryngeal nerve passes through the hyo-thyroid membrane between the hyoid and thyroid cartilage; after this the pain is often relieved for ten to twenty days, sometimes for as many as forty. We have had good results from the alcohol injections; though we have seldom succeeded in obtaining so long an interval of painlessness, still we have observed considerable relief to the pain and dysphagia, even in quite hopeless cases. Blumenfeld obtains complete abolition of sensation by resection of the superior laryngeal nerve under local anaesthesia. The bilateral division of the nerve had already been proposed and carried out with success by Axellis.

Nevertheless there will always be cases in which opiates cannot be dispensed with; though the views on this matter are at variance. While Moritz Schmidt made extremely sparing use of morphine, as subcutaneous injection near the larynx and as insufflation, his pupil and colleague for many years, Spiess, uses it much more extensively in cases of inflammation and after operations. He not only proves that under its influence operative wounds heal better, but that the local anaesthetic effect has a good influence on inflammation, and he thus extends the use of narcotics not only for laryngeal tuberculosis, but also for many other cases of inflammation of the upper air passages. Spiess has often seen surprising improvement in inoperable cases from submucous injections of 2 per cent. sterile novocain solution, given by means of a laryngeal syringe once or twice a day; and the same injection gives much relief in severe dysphagia. We are trying the effect of novocain injections; so far they have

been of service to us in several cases as local anaesthetics for the purpose of operation, as well as for the relief of pains. Kafemann, who supports Spiess's views without exception, has lately recommended, on the grounds of his own extensive experience, the pantopon of Sahli as an almost ideal local anaesthetic for inflammatory and nervous affections of the upper air passages.

The best caustic for tubercular ulcers is lactic acid, which was introduced by H. Krause, and has almost entirely superseded silver nitrate, tri-chlor-acetic acid, and chromic acid. It has an elective destructive action on tubercular tissue, and leaves unaffected mucous membrane practically intact. Therefore it is unreasonable to treat closed infiltrations with lactic acid, a procedure which has brought it undeserved discredit. For many laryngologists expressly warn against its use; Jurasz, for example, has seen much change for the worse after it. If it is desired to attack a closed infiltration an incision must first be made, as recommended by M. Schmidt. Lactic acid must be rubbed into an ulcer with moderate pressure by means of a small cotton-wool mop, the larynx having been first made insensitive. By the rubbing the soft necrotic tissue is mechanically removed, and the superficial part of the remaining disease sloughs off. By several repetitions of the caustic, the whole of the diseased tissue is gradually destroyed. For small ulcers very concentrated or pure lactic acid is used, for larger surfaces a 50 per cent. solution, or the strength may be increased from 25 to 80 per cent. The application must only be repeated when the grey sloughs have separated, and the local reaction has subsided, which usually occurs after eight to ten days according to the intensity of the cankerization. It is incorrect to paint the whole interior of the larynx with weak lactic acid solution, as is still sometimes done. As a substitute for lactic acid, which sometimes causes excessive irritation, Blumenfeld recommends the glycerine-ester of lactic acid.

The intermediate diiodal II contains 54.8 per cent. lactic acid, is milder in its effects and sufficient for many cases. The dilactate diiodal III contains 20.5 per cent. lactic acid, and more nearly approaches this in its caustic effect, but causes considerably less after-pain. The most concentrated preparation is the trilactate, which contains 87.2 per cent. lactic acid. For extensive use we prefer diiodal II, with which we have had good results.

Finally we may mention the internal administration of large doses of iodide of sodium, to be followed by inhalations of ozone or hydrogen peroxide lasting two to four hours, a method already mentioned under nasal tuberculosis, and by which Pfannenstill

has obtained remarkable results in severe cases of laryngeal ulceration.

Surgical treatment, which has hitherto been much more effective than those already mentioned, aims at removing as far as possible all the diseased parts. Circumscribed deep ulcers, infiltrations, and tubercular tumours are the most suitable cases for it. According to the position and nature of the disease (the single or double curette, or the cutting forceps, may be employed. The operation must take place under thorough local anaesthesia. If the parts are very irritable a preliminary injection of pantopon or morphia may be given. To the 20 per cent. cocaine solution that is used one or two drops of suprarenin may be added, which constricts the vessels and diminishes hæmorrhage, localizes the action of the cocaine, and thus prevents toxic symptoms, and brings out the tubercular tissue by removing purely inflammatory redness. Suprarenin also has the advantage of being able in a great part to replace cocaine; if it is added in the proportion of 1 to 1,000 a 5 per cent. solution of cocaine is sufficient to produce complete anaesthesia of the larynx (Bukofzer). Anaesthesia produced by painting on a 20 per cent. solution of alypin, or injecting into the submucous tissue a 2 per cent. novocain solution, is less intense and lasting, but not so liable to be accompanied by toxic symptoms. The addition of suprarenin to fluid for injection must be made with caution, especially if the heart is affected. According to Ephraim anaesthesia of the larynx may also be obtained by painting with 50 per cent. antipyrin solution, its action, however, is very slow, and varies much in different cases. The great advantage of antipyrin is that with its aid the concentration of the more toxic anesthetics may be considerably reduced; thus 50 per cent. antipyrin in 10 per cent. alypin solution acts as quickly as 20 per cent. cocaine, according to Ephraim. After the operation it is advisable to cauterize the raw surface with lactic acid, which acts on any deeper tubercular tissue and prevents later hæmorrhage.

In cases of extensive infiltration in positions where radical operations cannot be performed, such as the epiglottis, the aryteno-epiglottic folds or the posterior wall, either the most affected part is excised, or scarification, incisions, or cuts with scissors are made at the point where the swelling is greatest; the surface of the wound being afterwards treated with lactic acid. This will be applied several times between the operations, which may require to be repeated more than once. Such operations have had good effect in removing severe pain on swallowing, which resisted other treatment. If the dysphagia is caused by

severe infiltration of the epiglottis, then the free part of that cartilage must be amputated; for which purpose the red-hot snare is better than cutting instruments, as with its use troublesome hemorrhage is avoided. The removal of the epiglottis has no effect upon the deglutition movements; this is confirmed by the results of 240 such amputations, which Lockard-Denver has collected.

If these endo-laryngeal operations offer no prospect of success, tracheotomy is recommended by many writers for the purpose of influencing the disease favourably by giving absolute rest to the larynx. This operation is very highly valued by M. Schmidt, who found that local treatment of the larynx was seldom necessary afterwards. It is only indicated in the more severe and rapid cases of laryngeal tuberculosis with slighter disease in the lungs. When the expectoration is abundant its expulsion through the cannula is very unpleasant, both for the patient and those near him. Besides being a curative operation, tracheotomy is also required as a palliative in all cases of stenosis.

The experience of laryngo-fissure (thyrotomy) and sub-hyoid pharyngotomy has been less favourable. Both these operations can only be considered if the diseased foci are accessible in no other way, and then only if the lung disease offers a hope of recovery.

Total extirpation of the larynx for tuberculosis has been successfully performed by Gluck; it is not generally recommended, however, as it is too dangerous for phthisical patients. Surgical treatment also includes electrolysis and galvanocautery. Whilst the first has been generally abandoned on account of its slowness and difficulty, the latter enjoys increasing recognition. The galvanocautery is employed for ulcers, and also, according to Grünwald, for the puncture of infiltrations. The operation must be done after the larynx has been thoroughly anesthetized in the way already described, the point of the cautery being raised to a white heat. For puncture the action must be continued till the point can be moved in the hole made, that is, for about 5 to 10 seconds. The signs of reaction disappear in about two to three weeks, according to the extent and position of the disease, and the severity of the cauterization. The operation will perhaps have to be repeated several times. The range of usefulness of this method is almost without limits; there are practically no contra-indications to its employment; its action can be limited exactly to the diseased area; it is easy to carry out, and is well supported. Grünwald, Jurasz, and Mann consider the principal advantages to be its deep action, the

amount of reactive inflammation and hyperæmia of the tissue, and in the resulting scar formation, which prevents the spread of the disease. Lately this method has been almost exclusively employed in the laryngological clinics of Freiburg and Bâle. Killian also describes galvano-puncture as the one effective method for extensive and severe infiltrations; but he does not think it advisable to make more than two or three punctures at a sitting, as otherwise violent reaction, occasionally necessitating tracheotomy, may occur. On the other hand, Siebenmann attempts to destroy all the diseased parts at one sitting, and this procedure has given him excellent results without complications. Halle, Prese, Ed. Meyer, and Nolsenius are of the same opinion. Many warnings have been given against the use of the galvano-cautery for sub-glottic disease, as violent œdema may easily occur. We ourselves can warmly support the use of the galvano-cautery, which we have employed extensively; it can be combined with endo-laryngeal operations, such as curettage, and does not exclude other treatments, especially tuberculin.

The physical methods include Bier's hyperæmia, sun-rays, Röntgen rays, radium and the diathermic treatment of Nagelschmidt.

The congestion treatment has been employed by Grahower by means of a rubber band, which is applied round the neck below the larynx for several hours a day; a large convex pad may be placed under it on both sides to increase the pressure on the veins in the neck. The treatment has given good results to various writers, and it is also recommended by Jurasz. The subjective symptoms, such as cough and dysphagia, are specially influenced, as we ourselves have noticed.

Improvement has also been reported as a result of the direct exposure to sun-rays, which we can confirm from the experience of several cases. Besides the hyperæmic effect of the sun's rays there are various psychical factors introduced, such as faith in the healing powers of the sun and the benefit to the patient of being able himself to co-operate in the treatment, which should by no means be underestimated. Intelligent patients soon learn themselves to direct the rays of the sun into the larynx by means of an easily constructed mirror stand.

Unfortunately in Germany there is not sufficient sunshine, especially in winter, for systematic treatment, for which reason the reports from places in the high mountains have been the most favourable.

As there are no authoritative reports of bad results from either the hyperæmic or sunlight treatment, both methods may be

recommended for all cases in which more effectual means cannot for some reason or other be used, and also as an after-treatment for operations to prevent relapses. An advantage of both methods is that they can be carried out for a long time by the patients themselves without medical supervision, when they have once had detailed instruction and experience. Moreover, if the patients apply the sun-rays themselves, they may, if they are observant, be able to detect early suspicious appearances in the mirror picture, and call in medical aid at the right time.

The Röntgen rays are applied to the diseased part of the larynx by means of a specially constructed autoscope tube. There are many records of marked improvement, even cure, especially of lupus; possibly because lupus is principally situated at the entrance of the larynx and is so more accessible to the rays. A definite verdict upon this method cannot yet be given. There are still technical difficulties in its application, as the healthy tissue must be protected from the rays; the treatment makes great demands on the patience and will power of the sufferer. But the possibility of cure has been proved with certainty both on pathological and anatomical grounds for tubercular disease of the larynx in rabbits by Bruunings and Albrecht at the Freiburg laryngological clinic. For this reason attempts are constantly being made to apply the Röntgen rays from outside. The larynx is treated from both sides with the rays up to 1 to 2 erythema doses, and to obtain a sufficiently deep effect use is made either of a filter of aluminium, silver or leather, or the skin is first rendered anæmic by an adrenalin-novocain injection. The results up to now encourage the continuation of these attempts.

The radium treatment is still quite tentative and inadequate, but there is a better prospect now that special instruments have been made to introduce the radium to the diseased area.

Nagelschmidt has obtained rapid healing of laryngeal tuberculosis by means of the diathermic treatment, which will be described more fully under lupus; the reports hitherto received arouse the greatest hopes of this method for all tubercular diseases of the upper air passages.

With the local measures directed against the disease in the larynx, general treatment of the patient must play a principal part, as the lungs are practically always affected at the same time. Whether this must be carried out in an institution or not, must be decided for each case separately. Certainly there are patients of such strong character as not to require constant medical supervision; but the assertion of experienced sanatorium doctors must be believed, that even the strictest institutional

discipline is not always sufficient to restrain careless optimism. We cannot recommend treatment in the patient's own home. Though throat specialists are unanimous in stating that the favourable moment for local treatment of the larynx must not be allowed to slip by, yet we are glad to be able to say it cannot be asserted that there are many institutions in which this is now permitted. As soon as possible after an effectual operation general treatment must be carried out in a sanatorium or a health resort. The choice of place is chiefly a question of financial means; a place free from dust and wind, and with not too dry a climate, is preferable.

The treatment at watering-places must not be forgotten. Mineral waters act both on the digestion and assimilation, and also on the catarrhal complications in the air passages. Though we consider that for long cases other hygienic factors are much more important, still from our own experience we do not wish to undervalue the loosening of secretion and relief of the larynx which may be obtained from the use of mineral waters. The chemical combination of the water does not seem to us of great importance; the principal point is that expert local treatment of the tubercular larynx must be obtainable at the health resort.

We consider that the sparing use of the larynx is part of the general treatment in a narrower sense. Every injury and unnecessary exertion of the diseased organ must be avoided by means of strict discipline of the cough, by suitable diet, by loosening the secretion with inhalations, and aqueous or alcoholic compresses to the neck, by the sparing use of codein, diamin or heroin, by the prompt treatment of accidental catarrhs of the throat and nose, &c.; whilst in all severe cases absolute silence should be maintained for some months wherever possible. Whispering is only to be allowed when absolutely necessary. The maximum rest to the larynx is of enormous importance, both in estimating the length of treatment and for prognosis. Clearly it can be more easily obtained in a well-disciplined institution than elsewhere. For incurable cases it is an unnecessary hardship. It need hardly be said that absolute silence for two to three weeks must follow every extensive endolaryngeal operation.

In suitable cases we consider specific treatment to be a most valuable part of the general management of cases of laryngeal tuberculosis. There have been good reports of the result of serum treatment. Very much larger and more satisfactory has been the experience of the various tuberculins, of which Koch's deserve the preference. The method of use is the same as for disease in the lungs, and the latter usually regulates the treatment, as

it is the primary disease. The choice of case must be made with the most careful consideration of the state of the lungs and the general condition. The possibility of directly observing the influence of tuberculin on the larynx as a means of control should be utilized after each injection. Early redness and swelling entirely disappear. Smaller infiltrations are easily reabsorbed, larger ones require a longer time, according to their position. There is a possibility of a reactive necrosis wherever the deeper tissue, which may be covered with more or less healthy mucous membrane, is already destined to break down. In such a case it is only a question of precipitating the natural fate of most infiltrations. As a matter of fact a marked formation of ulcers under tuberculin has not been seen by competent observers. Tubercular ulcers offer the condition most favourable to cure with tuberculin, especially those that are more superficial. Blumenfeld saw old torpid ulcers which had previously resisted all treatment, even lactic acid, heal under tuberculin. For larger ulcers, which are usually also accompanied by infiltrations, it is better to accept the help of surgical treatment. Diffuse infiltrations, which resist most treatments, even surgical, can often be considerably reduced by means of tuberculin. In cases of severe necrosing infiltrations, and of deep ulcerations and perichondritis, complicated with mixed infection, such as are usually only met with in severe cases of pulmonary tuberculosis, tuberculin is powerless and is better omitted. According to Edmund Meyer, on the other hand, it is a matter of indifference whether the disease takes the form of infiltration, ulceration or perichondritis, or whether all three forms are combined. It has been the almost universal experience that the treatment of laryngeal tuberculosis has been greatly improved by the aid of tuberculin. It must be clearly understood, however, that the tuberculin treatment of laryngeal tuberculosis usually takes a long time, since there is generally also severe disease in the lungs, which draws, by virtue of its larger area, most or all of the tuberculin to itself, especially at the commencement of treatment, and only after the lungs are gradually saturated is the tuberculin free to act on the larynx. The fact may be emphasized that the use of tuberculin is by no means opposed to other therapeutical measures, and that we, as a result of large experience, most warmly recommend a combination of general, local and tuberculin treatment.

Lupus of the larynx generally requires the same treatment as tuberculosis. As, for the most part, it is situated at the entrance of the larynx, in severe cases amputation of the epiglottis and excision of the infiltrated parts of the aryteno-epiglottic folds may

be considered. The best results have been obtained by Moritz Schmidt with the curette and lactic acid, and tuberculin has been to him a considerable aid.

Prophylaxis. With regard to prevention of laryngeal tuberculosis in cases of open pulmonary disease advice has already been given in the sections on the treatment of the disease in the lungs and larynx. In general the cough and expectoration must be disciplined and treated if necessary, and the hygiene of the voice and larynx must be attended to, and a suitable diet given in cases of acute and chronic laryngeal inflammation in phthisical cases. The prophylactic value of tuberculin must not be underestimated. It acts on the mechanical irritation and inflammation of the larynx by relieving the cough, it lessens the expectoration and loosens the sputum, it decreases the opportunities of sputum being deposited in the cavity of the larynx, and above all it raises the biological powers of resistance of the laryngeal tissues to the tubercle bacilli.

4. TUBERCULOSIS OF THE TRACHEA OF THE LARGER BRONCHI.

Anatomical Changes. In the trachea and larger bronchi tuberculosis appears almost without exception in the ulcerating form. The number and size of the ulcers vary. In the trachea they may cover the whole tube, and produce necrosis of the cartilage, but as a rule they are superficial, and occur chiefly on the posterior wall. According to Cornet, tubercular tumours and lupus have also been found on the trachea. Cascating bronchial glands may break through from the exterior into the trachea or bronchi.

Symptoms and Course. A primary inhalation tuberculosis of the trachea or bronchi is extremely rare. Nearly always the ulcers arise from sputum infection towards the end of life. Since they occur in phthisical patients in the last stages no special clinical symptoms can be recognized. Usually they are first revealed at the autopsy.

Diagnosis, Prognosis, and Treatment. In rare cases the ulcers may be diagnosed with the laryngeal mirror, but their recognition is of no importance as the patient is usually in *extremis*. The prognosis is absolutely bad. No special treatment is required, at the most it could be only symptomatic.

CHAPTER V.

Tuberculosis of the Digestive Organs.

Before considering the tubercular affections of the several organs we may take a short glance at certain non-tubercular changes which frequently occur in tubercular patients and have a distinct importance from the point of view of diagnosis, prognosis, therapeutics and prophylaxis.

The most frequent affections of the mouth in tubercular patients are stomatitis and dental caries. Stomatitis occurs in cachectic conditions, more frequently in children than in adults. Caries usually commences at the neck of the incisor teeth, and is much more often met with in tubercular than healthy people; in childhood it is even a pathognomonic symptom, since children with circular caries can be recognized as having the lymphatic diathesis. The importance of stomatitis and dental caries is that both interfere markedly with the nutrition of the patient. Carious teeth also offer a place of lodgment and entry of tubercle bacilli, and doubtless play a part in the production of tubercular glands in the neck. A most rigorous care of the mouth and teeth from childhood is therefore very important and necessary for the treatment and prophylaxis of tuberculosis.

Of non-tubercular changes in the oesophagus, compression, decubital ulceration and traction diverticula may be mentioned. Decubital ulceration occurs in the last stages of phthisis, and is due to the weight of the larynx pressing the cricoid cartilage back against the vertebral column, and so producing a circular patch of necrosis of the mucous membrane at the junction of the pharynx and oesophagus.

Traction diverticula develop in consequence of the pull on the oesophagus produced by inflammatory adhesions following retraction of tubercular disease in the glands, lungs and mediastinal tissues. Much more frequently tubercular glands break

into the œsophagus as a result of peritendinitis, and by their subsequent fibrosis and retraction drag out the wall of the œsophagus in the form of a funnel.

Symptoms of œsophageal compression may be produced by an abscess from caries of spine and by large tubercular glands.

The consequences of the changes are difficulty of swallowing and retention of food. There are usually no indications for treatment.

As the pseudodyspepsia of tuberculosis has already been described there remain to be considered those diseases of the stomach which may complicate tuberculosis, especially acute and chronic gastritis. The appearance of these complications is partly due to a constitutional weakness of the digestive organs. They are of great practical importance since they often lead the patient to consult the doctor on account of gastric pains, loss of appetite, wasting, &c., while the lung symptoms, such as cough and expectoration, are more or less ignored. If a thorough general examination is not made the case is diagnosed and futilely treated as one of idiopathic gastric disease, until the primary tuberculosis reaches a stage in which it can no longer be overlooked. So that gastric symptoms demand a most complete examination of the whole body, especially of the lungs.

The tendency of tubercular persons towards attacks of acute gastritis may be explained by the increased toxæmia, and particularly by the extreme sensibility of these cases to slight errors of diet, such as cold drinks, &c. The gastric symptoms come on acutely with pain in the region of the stomach, furred tongue, rise of temperature and diarrhoea. There is also excessive secretion of mucus with marked diminution of the free hydrochloric acid, while alterations in the motor functions of the stomach can be hardly recognized.

In the treatment, complete abstinence as far as possible from all solid and soft foods for twelve to twenty-four hours is the most important point, only a little gruel, or some weak tea if there is much thirst, being allowed. Ordinary diet must be very cautiously resumed. In all cases rest in bed is required. Individual symptoms must be treated as the need arises. If the secretion of acid remains deficient, hydrochloric acid and pepsin must be ordered with the meals, while alkalis, if necessary, combined with belladonna, may be given for hyperchlorhydria.

Chronic gastritis may be the result of an acute attack, or it may be a consequence of swallowing the sputum or of a toxic action on the mucous membrane; in advanced cases it is usually due to chronic congestion of the mucous membrane of the

stomach, which is a part of a general portal congestion. In tubercular patients it assumes particularly the atrophic form, with the consequent mechanical insufficiency of the muscles (gastric atony), dilatation of the stomach as a result of the stagnation of the contents, increased secretion of mucus and diminution or absence of the gastric absorption. According to Permin, 23 per cent. of tubercular patients in stage I, 34 per cent. in stage II, 47 per cent. in stage III, and 75 per cent. in the last stage suffer from deficiency or absence of acid in the gastric contents; in the last class marked interstitial changes take place at least twelve to six months before death. Changes in the motile powers of the stomach are part of the general muscular weakness of tubercular patients, but occur with special frequency if over-feeding with large quantities of milk has been practised. The subjective and objective signs of chronic catarrh, atony and dilatation of the stomach, are not altered by the presence of tuberculosis. The motor and secretory functions of the stomach may be chemically examined in tubercular patients, if the passage of stomach tube is not contra-indicated. We may test the amount of acidity (three-quarters of an hour after breakfast, or three hours after lunch), the amount of mucus (best in the morning) and the motor powers of the stomach (six hours after food). Alterations of the secretion and motor power of the stomach with excess of mucus indicate gastritis, even if the nervous symptoms are very marked. In patients who object to the stomach tube and cases of advanced tuberculosis with loss of lung tissue and a tendency to hæmorrhage, the stomach may be mapped out after drinking a pint of fluid or inflated with carbonic acid gas (a teaspoonful of tartaric acid and bicarbonate of soda in a little water drunk quickly one after the other). The lowering of the motor function can also be detected by means of Ewald's solid test.

Tuberculosis and chronic gastritis often form a vicious circle, in so far as the tubercular mischief prevents the improvement of the gastritis, and this again influences unfavourably the tuberculosis. Therefore the treatment is certainly difficult, but is most urgently needed. A rigid dietary is not suited for these cases. One should aim at an easily digestible diet, neither too dry nor containing too much fluid, neither too hot nor too cold, not too much at one time, but food to be taken more frequently through the day. Change of residence, entailing change of cooking and of climate, often has a good effect on the appetite. Hydrotherapy, massage, electricity, and psychical treatment must be employed in addition. In cases of motor weakness with much mucus and fermentation washing out the stomach with warm

Ems water is most useful. Mineral water treatment is to be recommended; in cases of gastritis with deficient acid secretion especially the saline waters of Kissingen and Wiesbaden, in hyperchlorhydria Karlsbad or Vichy; the water is to be taken warm in the morning. Of drugs the most useful are the astringent silver nitrate ($\frac{1}{2}$ gr. in pill, 1 to 2 pills after food), or subnitrate of bismuth in large doses (150 to 200 gr. a day). Individual symptoms must be treated as they arise.

Non-specific affections of the intestines in tuberculosis have somewhat similar effects to gastric catarrh; there is a special liability to acute and chronic catarrh, and to amyloid degeneration.

Acute enteritis may occur in the early stages of phthisis in consequence of mechanical, chemical, or infectious irritation from the intestinal contents, and in weakly individuals is a serious, and often a fatal complication.

Chronic enteritis may develop out of the acute form. More often changes in the intestinal mucous membrane and muscle and nerve apparatus develop in phthisical cases in consequence of toxic influences, and take the form of congestion, atrophy, inflammatory swelling of the mucous membrane, or atony of the intestinal muscles. Since these non-specific affections cannot be clearly distinguished from tubercular enteritis, their treatment will be considered with that of the latter condition.

Amyloid degeneration of the intestines in advanced cases of phthisis not seldom accompanies tubercular intestinal disease. In consequence of circulatory disturbances amyloid ulceration of the mucous membrane often appears, especially in the lower part of the small bowel. The ulcers are smooth, and have sharp, punched-out edges, and the vessels in the floor of the ulcer undergo amyloid changes, so that it is not difficult to distinguish them from tubercular ulcers. The symptoms are vague, and the treatment is that for tubercular diarrhoea.

Non-specific affections of the liver which are frequently met with in tuberculosis are fatty and amyloid degeneration and cirrhosis.

Fatty liver, which is frequently found in autopsies on tubercular cases, arises, as in other forms of marasmus, from nutritional changes. Whilst the body fat diminishes, there is an excessive amount in the circulating blood, which causes a fatty deposit in the liver, and even a fatty degeneration of the liver cells. Unconsidered supersaturation of phthisical patients, especially with fats, may assist in its production. Icterus is absent; in very advanced cases of fatty liver the bile pigments are diminished, or even absent.

Amyloid degeneration of the liver affects the connective tissue and blood-vessels, and the parenchymatous cells only secondarily by pressure. In advanced amyloid, like fatty degeneration *scholia*, a diminution of the bile with urobilinuria, may occur; jaundice and ascites are absent. The liver is very much enlarged, uniformly hard, and quite smooth. The distinction between the fatty and amyloid liver cannot be made by palpation; but the changes in the spleen, intestines, and kidneys point to the correct diagnosis.

The combination of hepatic cirrhosis with tuberculosis of other organs, especially tubercular peritonitis and milary tuberculosis, is very common. The question whether the cirrhosis is primary and the tuberculosis secondary, or whether the opposite is the case, can be now answered by saying that hepatic cirrhosis, especially the hypertrophic form, produces a marked predisposition to tuberculosis, while the cases in which a primary tuberculosis gives rise to interstitial hepatitis, either through the blood or through the peritoneum, are very rare. At the same time one can understand that chronic fibrotic lung changes may lead to venous stasis in the liver, and that in consequence of this stasis there may be a gradual overgrowth of connective tissue, producing what is known as the cirrhotic nutmeg liver. If the changes in the liver are more than slight, since they increase the cachexia, they will aggravate the prognosis. The nutrition is unfavourably affected, and the antibacterial and antitoxic functions of the liver injured.

I. TUBERCULOSIS OF THE MOUTH AND TONSIL.

Anatomical Changes.

The forms of tuberculosis of the mouth are superficial and deep ulceration, polypoid tumours, and lupoid infiltration.

The ulcers, which are most common in the mucous membrane of the lips and cheeks, and along the edges of the tongue, commence as tubercles, which show through the epithelium, and afterwards caseate and break down, and by the confluence of neighbouring areas cause an obvious loss of tissue, covered by indolent, discoloured granulations. The edges of the ulceration are thin, uneven, eroded, and irregular, often studded with greyish tubercles; they are never sharply cut.

The nodular tumour, which appears on the tongue, is soft and fragile, bleeds easily, is single or multiple, and of the size of a hazel to a walnut. Caseation of the nodule causes a cold abscess, which discharges externally, but only by a small slit-like opening.

Lupoid infiltration may be due to lupus of the face spreading into the mouth; it presents a slightly raised, dark red unevenness with soft edges, which may last for a long time without superficial necrosis.

Infection of the mouth is usually due to bacilli of the human type, though it has undoubtedly been observed from bovine bacilli received through milk.

The great importance of the tonsils as a place of entry of the bacilli is not clear; they may be infected through the blood, the lymph, the sputum, the air, or the food. In a systematic observation of 100 tonsils removed from phthisical cases, we found not only old caseous nodules, but also recent tubercles with giant cells and bacilli, even when the tonsils were quite small and outwardly normal. Large caseous areas, and isolated tuberculosis of the tonsil, are rarer; when it occurs the caseation usually begins in the middle of the tubercle in a giant cell. Later ulceration develops, but not directly on to the surface of the tonsil, but first into one of the crypts, and from there it spreads to the surface. Lupus of the tonsil is rare; the primary form has only been twice observed with certainty.

Symptoms and Course.

Tuberculosis of the mouth is localized in the tongue, the cheek, the lips, the palate, and the gums. The closed form usually does not produce symptoms, while tubercular ulcers according to their size and position cause dryness, burning, a feeling of a foreign body, salivation, abnormalities of taste, and pains. With more extensive ulceration there will be pain on mastication and swallowing, excessive mucus, continuous irritative cough, fetor from the mouth, and sometimes fever. If the tongue is painful, speech will be affected. The glands in the neck are regularly infected.

The mouth is a rare place of localization for tuberculosis, as there are various agencies, such as the secretion of the saliva, the numerous vessels and wandering leucocytes, and the vast quantity of parasitic saprophytes, which hinder the development of tuberculosis. But in the later stages of tuberculosis the resistance of the patient is considerably lowered, and there are a large quantity of tubercle bacilli constantly passing through the mouth. If infection occurs it may be either secondary from the sputum during the course of phthisis, or primary from the air or food. The infection may be carried by the food, the finger, a foreign body or instrument, and may enter through a defect or crack in the epithelium, or a wound in the gum. Particularly the bacilli may enter into the hole left by a tooth extraction, where being

cut off from the action of the saliva they set up a tuberculosis of the mucous membrane or alveolar lining, from whence they pass to the neighbouring lymphatic glands and set up a general infection. The course is usually slow, especially in lupoid infiltration, and the nodular forms of tuberculosis of the tongue. In advanced phthisis there may be also amyloid disease of the kidney, bowel, and spleen.

Tubercle bacilli may remain latent in the tonsil, and pass through it without the gland itself becoming tubercular, so that the importance of the tonsil as a place of entry of the tubercular infection cannot be estimated only by the macroscopic or microscopic detection of tonsillar tuberculosis. But this latter condition is not so very uncommon, as there are many undoubted cases of primary tuberculosis of the tonsil. It can hardly be detected by the naked eye, since the organ is almost unaltered in appearance; it is not always enlarged, and rarely is diminished in size, but usually contains small yellow points. Only when breaking down and ulceration have occurred is the condition to be recognized with the naked eye. When the ulcers become superficial they are of the size of a lentil, round or oval, with a surface like bacon fat, their edges are sharply cut, rather elevated and red, while the tonsil itself is only slightly reddened. In lupus the tonsils are enlarged, with warty, stumpy, or conical projections from the surface. Ulcerations are rare.

Diagnosis.

The diagnosis of tuberculosis of the parts of the mouth accessible to the eye is not difficult, especially if a tubercular affection elsewhere gives a clue to the cause of the disease in the mouth.

Differential diagnoses must be made from herpes, aphthae, traumatism, and especially syphilitic ulcerations, and gummatous and carcinomatous nodules. It must first be remarked that the tubercle bacilli are very difficult to discover, and are only of positive significance if they are found in the tissue. Herpes is characterized by the serous vesicles. Aphthous plaques are larger, have a smoother surface, and heal quickly under treatment, as do also the traumatic ulcers due to a sharp tooth. The tubercular character of an ulcer in the mouth is indicated by its shallowness, atonic nature, the pale area round it, its irregular border, the yellowish grey granules near it, the absence of contraction, the slow course lasting for months or years, and the small amount of pain, with well-marked sensations of tension and dryness. Cancer is indicated by the crater-like floor and hard edges of the ulcer; while the ulceration of syphilis is multiple, very red, breaks down quickly, and has smooth, sharp, steep borders.

There is much difficulty in the diagnosis of the nodular form of tuberculosis of the tongue from gumma and cancer. Severe pains spreading up to the ear, with large hard glands under the jaw, usually limited to one side, are in favour of cancer; small glands on both sides, and multiplication of the tumours indicate tuberculosis. Syphilitic antecedents, other venereal symptoms, and general swelling of the glands point to a gumma. Administration of iodides on the one hand, or a tuberculin injection on the other, will clear up all doubt, as long as there is not a double infection with syphilis and tuberculosis. As a last resource in distinguishing carcinoma and tuberculosis a small piece of tissue may be removed for histological and bacteriological examination.

Tonsillar tuberculosis in the presence of ulceration is much more difficult to distinguish from syphilis. Without microscopic examination of some scraped off secretion for spirochaete and tubercle bacilli it may not be possible. The closed form cannot be diagnosed by the eye. The tuberculin diagnosis or the results of treatment may be of help. Lupus is characterized by the size of the tonsil and its nodular surface.

Prognosis.

Although spontaneous healing of tubercular disease of the mouth has been observed, the prognosis is generally not good. This is because the primary disease often quickly infects the intestines or lungs, and the bacilli may penetrate into the jaw.

The prognosis in tuberculosis of the tonsil is distinctly more favourable.

Treatment.

Treatment must be directed first to the general condition and the primary disease. Hopeless cases will be limited as far as possible to a non-irritating diet, and the mouth washed out with disinfecting solutions such as peroxide of hydrogen, 1-3 per cent. potassium chlorate, borax, and boric acid, while pain may be relieved by sucking ice, by painting with atypin (10-20 per cent.), or dusting on orlhoform or anæsthesin. Also 20 per cent. menthol, menthol orlhoform, antipyrin, iodoform, balsam of Peru, and tincture of iodine are recommended for diminishing the soreness. If the nodule is so placed that it can be done without causing much damage, it should be anesthetized, and removed with a galvano-cautery, or the curette; in the latter case the base left should be carefully rubbed with 50-75 per cent. lactic acid.

Tuberculosis of the mouth in patients with healthy, or only slightly affected lungs, should be treated without delay by a combination of general hygienic measures, tuberculin, and an energetic local treatment. Where possible the wide excision of

the disease, so that it does not return, should be performed. For tuberculosis of the gums the Röntgen-rays have been used with success.

Tubercular tonsils should be removed. The remaining ulcer may be treated with the galvano-cautery and lactic acid.

Prophylaxis. For prophylaxis a most careful attention to the mouth and teeth of children is required.

also a thorough disinfection of all dental instruments. Barbers' implements and instruments used for the teeth and mouth are still not properly attended to. There can be no doubt as to the necessity of removing all tonsils that cause a suspicion of tuberculosis. On the other hand it is doubtful if large tonsils, which are causing no symptoms, should be excised, owing to the possibility of allowing the entry of a tubercular infection. The tonsils are valuable protective organs for the mouth, which should be preserved as long as they are causing no harm. But very large tonsils can no longer perform the function of protection. We therefore take the view that it is better to spare those tonsils that are causing no symptoms, and are not of an excessive size.

2. TUBERCULOSIS OF THE PHARYNX.

Anatomical Changes.

Tuberculosis of the mucous membrane of the throat consists of a superficial growth of thick granulation tissue, rich in vessels, and infiltrated with cells. In this tissue tubercles with epithelioid cells and scattered giant cells are found, while tubercle bacilli lie between the cells of the granulation tissue in large numbers. Macroscopically, tuberculosis of the throat may be observed in the milium form and as a diffuse infiltration. Through the red and swollen mucous membrane the milium tubercles show; as they break down ulceration of a markedly lenticular character is formed.

Lupus of the throat also consists of a cellular infiltration of the mucous membrane, containing tubercles with large round and giant cells, which are often partly confluent. In its further course it may caseate and ulcerate; or some of the lupoid nodules may cicatrize, while others remain on the surface of the mucous membrane.

Symptoms and Course.

Tuberculosis of the throat shows itself especially by sensations in the neck, which may be like the feeling of a foreign body, a dryness or burning, or a persistent scratching or stabbing pain, which is increased by mastication, by speaking, and particularly

by swallowing, and which spreads up into one or both ears. The pain and swelling may so interfere with swallowing that no solid and very little liquid food can be taken. If the disease is situated in the soft palate, so that its movement is affected, the voice acquires a nasal tone; also fluids may be forced into the nose on swallowing. The secretion of mucus in the throat is increased, so that the patient is tormented with a constant desire to hawk or swallow. Marked fever is rarely absent. Swelling of the cervical and submaxillary glands can usually be detected; existing tubercular fever will be increased by the pharyngeal affection. The favourite point of localization is the soft palate, then the uvula and the posterior pharyngeal wall; also the whole oral portion of the pharynx may be ulcerated.

Tubercular ulcerations of the throat are more superficial than deep, with a tallow-like base often covered with granulation tissue; the edges are sharply cut, and irregularly corroded. In the neighbourhood of the ulcer isolated, sub-miliary tubercles may be seen, which will form fresh ulcers by necrosing. Diffuse tubercular infiltration of the throat is rarer. It penetrates more deeply into the mucous membrane, and gives it a gelatinous appearance; in the neighbourhood of these infiltrations large tubercular nodules may be also seen. If the uvula is affected it becomes swollen to the size of the thumb, and studded with hard nodules; if it remains free it becomes atrophic and stumpy. If the ulceration and infiltration are extensive the palate and uvula are not infrequently destroyed, or the palate may become perforated or adherent to the posterior pharyngeal wall.

Tuberculosis of the throat may be met at any age; it is more common in youths and adult males. It is very rarely a primary disease. Rosenberg saw in 22,000 cases of disease of the throat, twenty-two cases of tuberculosis, of which three were primary; Guilmann and others have also observed its primary occurrence. Secondary infection occurs most often from lung disease through the sputum, more rarely from the nose, the mouth or the larynx. Direct extension of tubercular laryngeal ulceration into the throat has been observed. In tubercular meningitis milium tubercles are sometimes found in the throat.

Lupus of the throat is also rare as a primary disease, but it has undoubtedly been observed in young individuals; when secondary it is usually combined with lupus of the skin, the nose, the mouth, or the larynx. It most frequently affects the soft palate or the uvula, more rarely the posterior pharyngeal wall. The affected part may have its movements affected, though disturbance of its functions scarcely ever occurs. Also sensation in lupus of the throat, in contrast with tuberculosis, is not at all

or only slightly, altered; even extensive lupoid disease is usually quite painless.

Macroscopically there can be seen either a very red, granular, dry, and glazed mucous membrane, or small nodules up to the size of a pea on an anæmic, non-inflamed surface. They are round, smooth, rosy-red, sometimes surrounded by a redder area, and may on healing leave bands of connective tissue. Caseation causes superficial or deep ulceration.

The course of lupus of the throat is very variable; it may spread over the throat in several days, it may remain stationary for months or years, or fresh lupoid nodules may be seen near smooth, glazed cicatricial areas.

Diagnosis.

The diagnosis of tuberculosis of the throat can usually be made without difficulty. The military, and even the submiliary, tubercles, which can be better examined through a lens, and especially the ulcer surrounded by military tubercles, are so characteristic that the diagnosis can be made during life. Also the search for tubercle bacilli in material removed from the surface of the ulcer often succeeds. Marked subjective symptoms never fail in tuberculosis. Herpes and aphthæ of the pharynx may be distinguished by their acute and favourable course. The mucous plaques of syphilis can on close inspection be easily separated from the lenticular ulceration of tuberculosis. The syphilitic ulcerations of a later period are more difficult to distinguish from tubercular ulcers; the former are deeper, have sharp worm-eaten edges, tend to cicatricial contraction, are not surrounded by grey granules, and may last for weeks and months without causing considerable symptoms. Other manifestations of syphilis or tuberculosis, the administration of iodide or tuberculin, or Wassermann's reaction will clear up the diagnosis in doubtful cases.

The diagnosis of lupus of the pharynx from syphilitic and tubercular ulcerations presents some difficulty, especially if there are no other areas of lupus. The very indolent nature and extremely long duration of lupus are distinctive. The ulcerations of lupus differ from those of tuberculosis, in that the edges are not sharply cut and seem more raised, and the floor is covered with indolent, pale, warty granulations, and they are not surrounded by the characteristic grey tubercles. Cicatrized lupus nodules appear as irregular white or light brown depressions or elevations, without having the band-like appearance of syphilis. Detection of tubercle bacilli in the scrapings from lupoid ulcers is seldom possible; a histological examination of a piece of excised mucous membrane is more useful.

Prognosis.

The prognosis of pharyngeal tuberculosis is generally unfavourable; but single cases occur in which the primary disease being completely healed the secondary lesion in the throat comes to a standstill. The secondary infection of the throat on account of the pain, difficulty of swallowing, and fever nearly always causes a rapid exhaustion. Also the passage of the bacilli from the pharyngeal lymphatics to the subdural space is not uncommon, and always fatal.

The prognosis in lupus of the throat is better. Though relapses are common, there is but slight tendency to spread of the disease. The general condition is but little, or not at all, affected.

Treatment.

In the treatment of tuberculosis of the throat the first place must be given to scraping the ulcers with a sharp spoon, and an energetic destruction of the infiltration with a galvanic or thermocautery; cauterization with lactic acid, silver nitrate, carbolic acid, chloride of zinc, or sodium formate may also be used. Michelson, v. Renvers, Rosenberg, and others have seen healing with tuberculin injections, while other authors have noticed spreading of the ulceration. Relief of symptoms may be given by painting with menthol, alpin, or cocaine, or by insufflation of orthoform or anaesthesin. Gargles may be used for disinfecting the throat, provided that gargling does not increase the pains. The diet must be most carefully supervised; often artificial feeding is required.

Lupus of the throat is also to be surgically treated with the sharp spoon, galvanic or thermocautery, if it shows no signs of spontaneous healing. Tuberculin has given good results in some hands, not in others. Symptomatic treatment is hardly necessary.

3. TUBERCULOSIS OF THE ŒSOPHAGUS.**Anatomical
Changes.**

The anatomical changes in tuberculosis of the œsophagus consist of ulceration, or in the development of single or disseminated spherical nodules of the size of a hemp-seed. The ulcers may remain small or become very large. Kümme! and v. Schrötter have described ulcers of the œsophagus which occupied $\frac{1}{2}$ to $\frac{4}{5}$ of the whole gullet. The thickened edges of circular ulcers may cause stenosis.

**Symptoms and
Course.**

Tuberculosis of the œsophagus usually causes no special symptoms; sometimes pain on swallowing, symptoms of obstruction, retro-sternal pains, and paralysis of the larynx are developed. Dysphagia may be quite absent even in severe cases, at other

times it may be produced by quite small and superficial ulcers. Primary disease has not been observed; there are about forty cases of secondary disease in the literature. Guisez in 500 œsophagoscopic examinations found tuberculosis of the gullet three times. The rarity of the condition is due to the resistance of the thick squamous epithelium, to the quick, easy passage of any sputum that may be swallowed, and to the frequent washing during the passage of fluids. The infection of the œsophagus from the interior is therefore very difficult. If it should occur it will be either due to a subepithelial spread from the pharynx or larynx, or to infection from swallowed sputum at some point that is deprived of epithelium. Predisposing causes are traumatism and corrosions, superficial ulcerations, traction diverticulum, and cancer. Infection through the outer wall is more common; caseating bronchial glands or disease in the lung may directly affect the œsophageal wall, and cause extensive destruction and superficial ulceration of the mucosa. The next most common mode of infection is the transference of infective material by the blood-stream and lymphatics from neighbouring organs.

Diagnosis.

The diagnosis is so difficult that it has only succeeded in recent years during life from the help of the œsophagoscope. By this means the ulcers, with or without granulations, and with scalloped edges, or tubercular nodules in the intact mucosa, or in the neighbourhood of an ulcer, become visible. The ulcers can be easily distinguished from the very pale mucous membrane which surrounds them. Nevertheless it is going too far to say that all tubercular patients with dysphagia, which cannot be accounted for by inspection of the throat or larynx, should be examined with the œsophagoscope. Even in the hands of the expert the use of the instrument in cases of pulmonary tuberculosis is fraught with difficulties and dangers (hæmoptysis); and the gain would be slight.

If there are symptoms of obstruction the differential diagnosis must be made from strictures due to corrosive poisons, syphilis and cancer; the latter is not rare in combination with pulmonary tuberculosis. Important also is the recognition of caseous tracheo-bronchial and mediastinal glands, since these are the most common causes of tuberculosis of the gullet. With the help of the Röntgen-rays a probable diagnosis at least can be arrived at.

Prognosis and

Treatment.

The prognosis is uniformly unfavourable, since the disease in this situation interferes with the general treatment.

Treatment by painting the ulcers with lactic acid has been attempted with the help of the œsophagoscope. This may relieve

the difficulty of swallowing, and if the ulcer is not too large may induce healing. But in most cases treatment will be limited to giving a suitable diet and to controlling the pain with opiates.

4. TUBERCULOSIS OF THE STOMACH.

Anatomical Changes.

Miliary tubercles, ulcers, and tubercular nodules have been observed. Besides the ulcerating and hypertrophic forms French authors have distinguished a purely inflammatory form, with subdivision into the mucous, the diffuse submucous, and the circumscribed submucous sclerosis; the last is the most important, as it is always situated at the pylorus, and leads to stenosis.

The tubercular ulcer of the stomach is the most important form, since both the granular and nodular varieties have a great tendency to necrosis. It is produced, as is the ordinary peptic ulcer, by circulatory changes, especially tubercular endarteritis of the supplying vessel. The pylorus is the site of predilection on account of its great richness in lymph follicles. The ulcer, which penetrates the mucosa and submucosa down to the muscle, may be single or multiple, may remain small, or may cover an area of 100-200 sq. cm., and more. The ulcer is irregular in shape or oval, usually at right angles to the long axis of the stomach. The edges are thickened by leucocytic infiltration, and are undermined or overhanging, so that the tubercular gastric ulcer is funnel-shaped, with the apex of the funnel towards the mucosa and surrounded by caseous material; while the edges of the simple gastric ulcer are in steps. At the edge and base of the ulcer are typical miliary and submiliary tubercles. The ulcer being situated at the pylorus in consequence of fibrous changes it may cause pyloric stenosis and adhesions between the pyloric region, the liver, and the bowel.

The submucosa in the neighbourhood of a tubercular gastric nodule is usually occupied with a hard infiltration, the underlying serous coat is usually unaffected. The nodular form of tuberculosis of the stomach by setting up diffuse infiltration leads to a considerable diminution of the size of the organ.

Symptoms and Course.

Miliary tuberculosis of the stomach causes no clinical symptoms. Even large tubercular ulcers may cause no marked symptoms; in other cases vomiting and gastric pains, increased by pressure and food, may be produced. Hæmatemesis is rare; perforation, fistula, perigastritis, and cicatricial stenosis even rarer. In any case the efforts are much slighter, and more indefinite than those caused by simple ulcer. The

comparative absence of pain has been explained by the deficiency of free hydrochloric acid. If the disease is situated at the pylorus, to the pain and frequent vomiting after food are added the symptoms of dilatation of the stomach with periodic increase in the motor insufficiency. As a consequence of the pyloric stenosis hypersecretion and hyperchlorhydria occur. But there are no specific symptoms to differentiate the condition from other forms of stenosis.

Tuberculosis of the stomach is very rare, it has not yet been observed as a primary disease. This is due to the poverty of the gastric mucosa in lymph follicles, and to the fact that the motor functions of the stomach are usually increased in phthisis. Whether the normally acid contents of the stomach have a bactericidal action on the tubercle bacillus and so prevent infection is still doubtful, but it is very probable.

It is more often due to an infection through the blood-stream as a part of general military tuberculosis; but this form has no clinical importance. There is also the possibility of the infection spreading by contact from a neighbouring organ, e.g., the spleen, to the serous coat, and penetrating the muscular layer. Lastly, lymphatic infection may occur from tuberculosis of the glands or peritoneum. Infection of the stomach from intestinal contents conveying tubercle bacilli by means of antiperistaltic action is very difficult to understand. The multiple ulcers, usually at the pylorus, which may occur in the final stages of intestinal tuberculosis, are without practical interest. Gastric tuberculosis is more common in children than adults in consequence of their smaller powers of resistance, and greater liability to military tuberculosis.

Tuberculosis of the stomach runs a chronic course. Perforation and fatal peritonitis are very rare; still rarer is a fatal hemorrhage from erosion of a vessel.

Diagnosis. It may be remarked that phthisical patients may suffer from simple gastric ulcer, also

that tubercle bacilli may settle in a carcinomatous affection of the stomach wall. The diagnosis of tubercular ulceration of the stomach can therefore never be made with certainty, but only as a probability. The nodular form of gastric tuberculosis will usually be either overlooked or considered to be cancer; the age of the patient may be of some help.

With Petruschky and E. Fischer we recommend the diagnostic tuberculin injection; but it is only of value if it causes an undoubted local reaction; Fischer has observed this in the form of an increase in the pains and nausea.

It seems to us that the practical conclusion is that for the explanation of severe gastric symptoms in non-tubercular patients gastric tuberculosis need not be considered, and that in tubercular cases simple ulcer and cancer are more common than tubercular ulcerations.

Prognosis.

The prognosis of gastric tuberculosis is, as such, not unfavourable, since the occurrence of perforation need not be feared; but the co-existence of a primary pulmonary or intestinal tuberculosis in nearly all the cases makes the outlook very bad.

Treatment.

In the treatment of tubercular ulcers experience fails us, so we are driven back on the measures for simple ulcer. Rest as complete as possible for the body and stomach, and a careful fluid or soft diet, not too great in amount, are to be recommended. Tepid compresses, sub-nitrate of bismuth (15 gr. three to five times a day, before food), silver nitrate in pills, combined if the pains are severe with orthoform or amethystin ($\frac{1}{2}$ to 5 gr.) may be used. If the pains are excessive morphia and belladonna suppositories may be given. E. Fischer and Petruschky report healing with tuberculin, which may be used when there are no other indications for treatment, as long as the case is not hopeless for other reasons. If there is hæmatemesis rectal feeding is required, or jejunostomy may be called for. For perforation and marked stenosis an operation is also demanded. The nodular form may be treated with resection, the caseous glands being also removed.

5. TUBERCULOSIS OF THE INTESTINE.

Anatomical

Changes.

The richness of the intestinal mucosa in follicles is a predisposing cause of infection. The solitary follicles and the Peyer's patches are the primary sites of tuberculosis, which therefore especially occurs in the lower part of the ileum, the cæcum, and the vermiform appendix, and is more rare in the upper and lower parts; but any portion of the tube from beginning to end may be the seat of tuberculosis.

Isolated or multiple nodules first appear in the follicles; they may calcify, but usually necrose one after the other, become confluent, and form tubercular ulcers, which may be roundish, elongated, or irregularly scalloped. The ulcer usually extends circularly in the direction of the vessels and lymphatics, and so is at right angles to the long axis of the bowel, in contrast to the longitudinal typhoid ulcer; it may extend right round in the form of a ring or girdle.

The edges of tubercular ulcers are usually raised and infiltrated; they are often undermined, studded with breaking-down granules. The ulcers are of variable depth, and may pass through the muscular and serous coats, and cause a perforation. Inflammatory thickening of the serous coat and adhesion to the neighbouring organs are usually present, so that perforation into the free peritoneal cavity is rare.

Tubercular intestinal ulcers have a great tendency towards connective tissue formation and cicatrization; the lumen of the bowel may thus be narrowed, or by the contraction of a circular ulcer a more or less severe stenosis may be formed. Such strictures usually form near ulcers, they are often multiple, and are of great clinical importance.

Tubercular tumours, the hypertrophic form of intestinal tuberculosis, may be produced by an inflammatory tubercular infiltration of all the coats of the bowel. The serous coat is much thickened, the muscular layer hypertrophied, and on the mucosa are polypoid, shaggy, nodular, or diffuse thickenings. Inflammatory adhesion to the neighbouring parts, cicatricial contraction and strictures usually occur, which may lead to considerable narrowing of the bowel and chronic intestinal obstruction. This variety is usually situated at the ileo-cæcal region, and may form a tumour. In the ascending colon the hyperplastic form has also been observed as isolated tubercular tumours. Both may be confused with cancer, especially if the peritoneum, the mesenteric glands, and the vermiform appendix are matted together into a regular, compact mass.

Where the serous coat is absent, as in the rectum, abscesses and fistulae form around the bowel. At least 60 per cent. of all rectal fistulae are of tubercular origin; the majority of these are of the muco-sulcutaneous variety. They betray their tubercular nature by the undermined edges, the flabby granulations, and the grey granules.

Tubercular rectal polypæ, which are rarer than tubercular rectal ulcers, may also be met with. A still rarer condition is lupus of the anal region.

The pathological importance of intestinal tuberculosis is not yet exhausted. According to the observations of Senekenberg in the pathological institute at Frankfurt, large quantities of tubercle bacilli are carried from the intestinal lesions by the portal circulation and thoracic duct to the lungs and general circulation. This overloading of the blood and lymphatics with tubercle bacilli accounts for many cases of miliary tuberculosis, and has a great influence on the course of pulmonary tuberculosis. It is now

certain that intestinal tuberculosis is a chief source of blood infection in chronic tuberculosis, and the fresh infection may aggravate the pulmonary disease.

Symptoms and Course.

The clinical symptoms of intestinal tuberculosis are not clear and uniform; they depend on, first of all, to what degree the intestinal nerves are implicated and irritated by the ulcers, and to what extent motor and sensory changes are produced. Further ulceration may cause symptoms connected with the peritoneum, or bleeding.

Diarrhoea is the most important of the symptoms due to motor irritation. Troublesome diarrhoea, especially if it is severe and resistant to treatment, and if it occurs at night, in phthisical patients, is always very suggestive of intestinal tuberculosis; it is produced by the caseation of the follicles and the attendant severe catarrh. The stools have a penetrating odour, they are of a light grey, clayey colour, and often contain mucus, undigested food, and much fat. Blood and pus cannot generally be recognized by the naked eye.

The frequency of the stools depends on the position of the disease. In tuberculosis of the ileum they may not be frequent, or there may even be constipation, while with disease of the lower colon or rectum there is always diarrhoea. In the last stages, in consequence of senescence, the stools may be held back.

The diarrhoea is almost always accompanied by peristaltic movements and loud borborygmi, which often cause peristaltic pains, and are signs of commencing senescence. Tubercular intestinal ulcers, unlike gastric ulcers, cause no, or only slight, local pains, but there is tenderness on pressure in the region of the caecum or navel. But if the intestines are overdistended by meteorism, persistent, spontaneous pains will be produced; the passage of mucus in cases of spastic constipation will also cause colicky pains, while the squeezing of hard faecal masses through the ulcerated, partly contracted bowel may cause great agony. Slowly commencing, but persistent, localized pains are indicative of peritoneal irritation of the surface of the bowel, if they are associated with local tenderness, nausea, or vomiting, and a rise of temperature. If the serous coat becomes perforated there will be localized or diffuse pains, and perhaps rigors, and the clinical picture of local or general peritonitis, the amount of which is determined by the grade of matting and adhesions.

Large hæmorrhages are rare; they are characteristic of ulceration in the rectum. They are more often brought about by mechanical irritation than by erosion of the vessel wall, and are

usually very intense and persistent. Slighter bleedings often occur, and the blood frequently cannot be recognized macroscopically.

The localization of tubercular ulceration in the vermiform appendix may produce the symptoms of appendicitis, and its consequences. In chronic cases board-like infiltrations, or abscesses, may form, with fistulae, either externally, or into the rectum, bladder, or vagina. Infiltrations round the rectum are very common, and lead to proctitis, and periproctitic abscesses and fistulae. About a third of these are clinically cases of primary tuberculosis, and anal fistulae are very common results. Rarely they may occur without symptoms; generally there is pain on pressure, especially at stool, which is relieved when the pus is discharged. The rectal and anal fistulae keep up a chronic suppuration, frequently with slight fever, and after a time cause a certain amount of illness, if they are not dealt with surgically. These fistulae, even in cases of intestinal tuberculosis, are not in all cases tubercular.

Stenosis causes special symptoms, which from the point of view of treatment it is most important to recognize. In the small bowel cicatricial strictures are especially frequent; thus showing that tubercular intestinal ulcers have a greater tendency to heal than is usually thought. Slighter degrees are overcome by a compensatory hypertrophy of the muscle above the stricture; and on account of the soft state of the intestinal contents and the effect of diarrhoea, in hurrying the ingesta through the constriction, it may not be noticed for some time. When compensation fails in consequence of increasing contraction, clinical symptoms of obstruction will be produced; distension of the bowel above the stenosis, general meteorism, difficulty of breathing on account of upward displacement of the diaphragm, marked peristalsis, nausea, periodic attacks of colic, and vomiting which may become faecal. The colic is characteristic. The tightly filled coils of bowel above the constriction stand out as stiff, often board-like, tumours. The pains and hardening come on in spasms, last several seconds, and then suddenly cease, while at the same time a noise indicates the passage of fluid and gas through the stenosis.

Whilst stenosis from cicatricial contraction of a circular ulcer is much commoner in the lower third of the small intestine, obstruction due to the hypertrophic form of intestinal tuberculosis usually occurs in the ileo-caecal region, more rarely in the ascending colon. Ileocaecal tuberculosis at first only causes dull persistent pain and tenderness, and afterwards, in consequence of

advancing stenosis, colicky pains, as described above, and frequent vomiting. From the surgical point of view these ileo-cæcal tubercular tumours have been divided into three stages; in the first stage there are pains in the right iliac fossa, symptoms of commencing obstruction alternating with diarrhoea, and a distinct muscular resistance over the cæcum; in the second a tumour of the cæcum can be felt and often seen, with a distinct border in its lower part; if no operation is performed the third stage with abscess and fistula is reached, leading sooner or later to an inevitably fatal termination.

Tuberculosis of the bowel is often primary; Heller and Wagner found twenty-eight such cases in 600 autopsies. Recent observations show that it is by no means rare in children and young people; but it is still uncertain whether the frequency is due to the propensity of children for putting anything within reach into their mouth, or to the large amount of milk taken, or to a greater permeability of the mucous membrane. The point of importance is that bovine bacilli, which are but slightly virulent for adults, may in children produce a primary intestinal tuberculosis. But we do not consider that food infected with bovine bacilli has much tendency to infect adults in general, and healthy adults in particular. The mother's milk so very rarely contains bacilli that it has no ætiological importance. Other foods which are accidentally much infected with tubercle bacilli may of course produce intestinal tuberculosis. But more important are the tubercle bacilli which are inhaled, deposited in the mouth and then swallowed with the food, thus giving rise to deglutition tuberculosis. This, however, does not always occur in the intestine, since the bacilli can pass through the intact epithelium, and also the intestinal wall, without leaving any visible effects behind.

Primary tubercular ulceration of the bowels usually has a strong tendency towards healing. But as this form usually occurs in children, who have but a small power of resistance to a general spread of infection, it runs, as a rule, an unfavourable course. The fatal ending is due to marasmus, or to general or meningeal tuberculosis.

Secondary intestinal tuberculosis is much more common. Eisenhardt in 1200 autopsies on tubercular cases found the intestine affected in 367 cases. Since Bollinger's figures show that of these 367 cases only three would be without tuberculosis in the lungs, it is clear that intestinal tuberculosis is a common complication of chronic phthisis, and that infection from swallowed sputum must be the most frequent cause of the disease. The anti-bacterial action of the digestive juices, the quick passage and

slimy nature of the sputum, make it probable that infection only occurs when there is a great amount of bacilli, or but little food is being taken. These conditions are best fulfilled in the advanced stages of phthisis with cavities, when the sputum is often swallowed. Less important factors are the swallowing of bacilli from outside, which have lodged in the mouth, the virulence of the bacilli, a feeble state of the tissues, and solutions of continuity in the mucosa. Infection of the bowel through the lymphatics, especially from the peritoneum, is rare; and rarer still is infection through the blood-stream as part of a general miliary tuberculosis.

The course of secondary intestinal tuberculosis depends on that of the primary disease. The disease in the lungs may be severe and in the intestines slight, or the opposite may be the case, or both may be either slight or advanced. Arrest and improvement are quite frequent, and healing may occur. Stenosis in the small bowel is always a sign of a tendency to healing, but it may be associated with other active ulcerations. On the other hand there are cases in which the diarrhoea cannot be checked, and the disease runs a rapid course. Wasting and anaemia accelerate the disease in the lungs, even if it is only quite slight, and raise the temperature considerably. Complications such as perforation into neighbouring organs or the peritoneum, or infection of the mesenteric glands, hasten the end, often by starting a miliary tuberculosis. The frequent occurrence of the miliary form can be explained, since B. Fischer has shown that in cases of tubercular intestinal ulceration the blood is constantly overloaded with tubercle bacilli.

Diagnosis. There is no particular difficulty in the diagnosis of intestinal tuberculosis if some

of the above-mentioned symptoms occur with manifest tuberculosis in another organ, especially the lungs. If this is absent the diagnosis may be very difficult. Fever, the appearance and constitution of the patient, the family history, and history of the disease, may point towards the tubercular nature of the intestinal symptoms.

The detection of ulceration is very difficult, since it often causes no symptoms. Diarrhoea is absent in the earlier stages; in fact, constipation is just as common as an early symptom. Blood, pus, and tissue shreds can generally not be distinguished by the eye in the loose stools. Occult bleeding is so important for the diagnosis, especially if diarrhoea or other obvious signs are absent, that the faeces should be examined for blood.

The faeces, after three days' abstinence from meat, may be examined in the following simple way, recommended by Rodier. A piece of fresh

material of the size of a pea is placed with a glass rod in a few cubic centigrammes of water, and boiled to prevent fermentation. In a second test-tube, 1 c.c. of benton solution and 5 c.c. of a freshly-prepared 2 per cent. peroxide of hydrogen solution are mixed together. One or two drops of the fluid containing faeces are added to this; if blood is present a grey, blue-green, or blue colour will appear. The test is very delicate.

Tubercle bacilli cannot regularly be found in the excreta, even with the help of the antiformin method. The detection in cases of phthisis is not absolutely indicative of intestinal tuberculosis, since they may be due to swallowed sputum. Also tubercle bacilli may be accidentally swallowed and appear in the faeces. The mere discovery of acid-fast organisms in the stools does not prove that they are tubercle bacilli. But although not conclusive the discovery of the bacilli greatly strengthens the clinical diagnosis of intestinal tuberculosis, if there is no open disease in the lung; and the diagnosis gains in certainty if the bacilli are contained in portions of tissue.

The very penetrating odour of the stools, and a marked indican reaction of the urine, are only indicative of much intestinal putrefaction.

If the diagnosis of intestinal tuberculosis is clear, frequent and severe haemorrhages point to the rectum as the seat of disease. The disease in the rectum, and also in the sigmoid flexure, can be inspected with the sigmoidoscope; the typical ulcerations, infiltrations and erosions of the follicles can be seen situated in a diffusely red mucosa, covered with pus and mucus, often bloodstained.

Strictures of the bowel may be due to tuberculosis or syphilis; tuberculosis in other organs indicates the former, the history and venereal symptoms point to the latter. Lately in the clinic at Bâle the diagnosis of a tubercular stricture has been made by a radiogram, taken five to six hours after a bismuth meal, a time when a stricture of the small bowel in its lowest part will be most clearly seen.

Ileocaecal tuberculosis is difficult to diagnose; it may be confused with cancer or chronic perityphilitis, also with scybalæ, sarcoma, actinomycosis, right-sided floating kidney or renal tumour, gall-bladder disease, ovarian tumour, encysted fluid in connection with disease of the female genital organs, and lastly with tubercular disease of the small intestine, the pelvic bones or the spine.

We may limit ourselves to the most practically important differential diagnosis between ileocaecal tuberculosis, chronic perityphilitis and cancer, but when all the points have been considered mistakes are still possible. This is specially so in the diagnosis between tuberculosis and cancer; even at an operation, or on the

naked-eye examination of a specimen, a definite opinion may not be possible, and can only be given by the aid of the microscope.

In favour of chronic perityphilitis are an acute onset with fever, &c., tenderness on pressure at McBurney's point, the detection of a surrounding effusion by very light percussion, absence of symptoms of stenosis, normal size of the inguinal and crural glands, elevation of temperature of shorter duration, and especially the detection by palpation of a tender swelling of the shape of the vermiform appendix in the ileocaecal region. Attacks of nausea and vomiting are also more common with chronic appendicitis.

In favour of cancer of the caecum are the older age of the patient, sharp limitation of a movable compact tumour, rapid cachexia, constant pain, slight or no symptoms of stenosis, blood in the stools, sometimes fresh and obvious, sometimes only on testing, absence or rarity of pus in stools, rise of temperature only in the last stages, and negative diazo-reaction in the urine.

Points indicative of ileocaecal tuberculosis are the younger age of the patient, tuberculosis elsewhere in the body, very chronic course, often lasting several years, a stiff, more or less fixed, irregular infiltration of an elongated sausage shape, characteristic symptoms of stenosis (obvious intestinal peristalsis, alternations of obstruction and diarrhoea), and coliclike attacks of obstruction, beginning with pains and peristalsis, then noises like a suction syringe, followed by subsidence of the pains and diminution in size of the abdomen. Small amounts of blood often appear in the stools, pus is more rare; tubercle bacilli can be frequently found, the temperature is raised, and the diazo-reaction positive.

Stierlin recommends the use of radiography five to six hours after a bismuth meal. Absence of the shadow of the caecum and ascending colon between the shadows of the lower ileum and the transverse colon is typical of early as well as of advanced cases; so that the diagnosis may be made by the radiograph, when it cannot be clinically. Stierlin has confirmed all his cases of radio-diagnosis by an operation; and explains the absence of shadow in the affected caecum and colon by the fact that the contents are forced so rapidly through this part that sufficient bismuth cannot collect to cast a shadow; whereas normally there is a relative delay in the caecum.

Test injections of tuberculin are generally of little value as the intestinal tuberculosis is nearly always secondary to disease elsewhere; but they may be used if there is no obvious primary disease, or if the tubercular nature of this is not obvious. It is

only contra-indicated if constant pain at localized spots points to areas of peritonitis due to deep ulceration.

Perirectal abscesses and fistulae can be generally recognized by the finger and probe. A suppurating hæmorrhoid or an abscess in connection with typhoid fever may give rise to difficulty. The rectal fistulae of diabetics are nearly always due to tuberculosis. A diagnostic tuberculin injection may irritate a tubercular fistula.

Prognosis.

The prognosis is always serious, and is absolutely bad in early childhood, and when the disease is secondary to an advanced pulmonary tuberculosis. Only the primary form in young adults, and the cases secondary to limited and favourable lung disease show sometimes healing or marked improvement. In nearly all cases the classical dictum of Hippocrates that "diarrhoea occurring in a case of consumption is fatal" has not lost its truth.

Deercal tuberculosis is rather more favourable, since it usually occurs with disease in the lungs which is tending to connective tissue formation.

Tubercular rectal fistula and abscesses with suitable treatment do well; but according to our observations they are frequently followed by pleural effusions.

Treatment.

In the treatment of intestinal tuberculosis in phthisical patients it is first necessary to cut off the supply of material containing bacilli. The swallowing of sputum in older children and adults must be absolutely forbidden; in young children this is useless, and all treatment is therefore hopeless.

The diet must be suitable and nourishing, but too much must not be taken at one time. Cases must be treated individually, and the patient must take as much milk, cream and fat as is suited to his case.

As a strict diet in cases of acute diarrhoea, albumen water (the white of one to two fresh eggs in a cup of boiled water, with a little salt) may be specially recommended, also thick soups and weak tea and toast.

In chronic cases of diarrhoea use may be made of pigeons, chicken or veal broth, thickened with oatmeal, groats or rice; or of spinach, asparagus, cauliflower or potatoes cooked with milk; or of white meat or fish. Prepared foods may be required. Fat meat and rich fish, salads, sugar, sweet fruits, and strong sauces are to be forbidden. When milk is well borne, that is, when it does not increase the diarrhoea, it may be ordered in frequent small quantities. The addition of one to two teaspoon-

fuls of lime water or one of cognac may be an improvement, or it may be taken in tea, barley water, or corna. In other cases kéfir or yoghurt may be of service. It is useful to wash out the bowel by taking $\frac{1}{2}$ pint of warm mineral water (Ems, soda, Carlsbad, &c.) early in the morning. Too much fluid, and especially cold drinks, must be forbidden.

The dietetic treatment must be combined with absolute bodily rest, with hot packs, warm baths, and temperate frictions.

The specific treatment may be employed if the state of the primary disease does not exclude it. But no dogma and no plan can be laid down with regard to any treatment. A sudden profuse diarrhoea may compel an alteration in the whole treatment. During the open-air cure the whole body must be kept properly warm by remaining in bed. Acute attacks render drugs necessary and compel the intermission of tuberculin treatment.

A large number of drugs are employed, but not seldom they all fail. If administered during the attacks of diarrhoea alone they nearly always fail; they must be continued for weeks and months, but a change in the preparation may be frequently tried. Without giving a complete list we will name a number of drugs which are the most useful. The smaller doses are for children, the larger for adults.

Preparations of tannic acid and tannalbin (15 gr.), tannigen (7 to 15 gr.), tannyl (15 to 45 gr.), tannoform (7 to 15 gr.), tannocol (7 to 15 gr.), tannismut (15 gr.), can all be taken several times a day. Ewald recommends decoction of calumba with tannigen and salicylate of bismuth.

Of the bismuth salts there are bismuth subnitrate (5 to 15 gr.), the subgallate (5 to 15 gr.). The latter, dermatol, has been praised for its prolonged astringent action; according to our experience it should be given in amounts of at least 60 gr. a day; in severe cases in adults it may be given as bismuth subgallate 15 gr. with extract of opium or pantopon six times a day. Fleiner recommends in cases of rectal ulceration that insufflations of subnitrate of bismuth should be directly applied through the rectal speculum, or the same drug may be given as an enema with warm oil. In the rare cases in which tuberculosis is localized in the lower colon large starch enemata are useful.

Liebermeister particularly recommends oxide of zinc (1 to 3 gr.); Boas uses calcium carbonate and calcium phosphate (15 gr. of each in powder).

In severe cases, especially with pain, opiates are necessary, unless they are contra-indicated by the tender age of the patient. Tincture of opium may be given in doses of 3 to 15 minims several

times a day. We recommend that small doses of 5 minims should be given every two hours. If tenesmus is present it should be given as a suppository. Opium should not be administered to infants, and with adults it should not be continued for more than three to five days at a time. In cases of colic due to stenosis morphia injections are the best treatment. Owing to its slight depressing effects on the respiratory organs, pantopon injections may be preferred (15 minims for adults, 4 to 7 minims in children, of a 2 per cent. solution). Pantopon may also be given in drops before food (for adults 10 to 30 drops of 2 per cent. solution three or four times a day, for children of 2 years 2 drops, and for each year 1 drop more up to 6).

If blood is mixed with the stools gelatine may be given by the mouth (one dram of a 10 per cent. solution that has been boiled), and at the same time by the rectum in a small enema with bismuth and opium. The treatment by regular irrigation of the rectum and rectal application of subnitrate of bismuth employed by Jos. Müller may be useful in severe cases.

An enema of two pints of warm water is given in the morning, which the patient must expel at once. An hour later, by means of an irrigator and a large soft india-rubber catheter, one to two dessert-spoonfuls of bismuth suspended in half a pint of warm water is run into the bowel; after ten to fifteen minutes the water is drawn off, while the bismuth remains in contact with the mucous membrane. If after prolonged use of this treatment pain is caused, five to ten drops of tincture of opium must be added.

For regular washing out of the bowel mineral waters or disinfectant and astringent fluids may be employed, such as salicylic acid solution (1 in 1,000), tannin (3 in 1,000), or silver nitrate solution ($\frac{1}{2}$ in 1,000).

The chronic constipation in early cases of intestinal tuberculosis, and the diarrhoea and tenesmus due to accumulations in the lower bowel, frequently require treatment. The diet should be rich in cellulose, and should contain vegetables, stewed fruit, marmalade, brown bread, honey, and butter. Systematic administration of oil, which diminishes both the motor and sensory irritation, and has a favourable effect on the colon and rectum, should be ordered.

For adults $\frac{1}{2}$ to 1 pint of warm olive or linseed oil, in children one-third of this quantity, is introduced into the rectum with the patient in the left lateral position, which must be maintained for half an hour after; after 1 to 2 hours more of rest in bed the patient goes to stool. Fleissner has obtained better results from the addition of creosote to the oil (1 in 100). John Müller uses only 3 dr. introduced through a tube 8 in. long.

There are no fixed indications for the surgical treatment of

intestinal tuberculosis. The general condition of the patient, the amount of the disease in the lung, the severity of the operation required, and the duration of the anaesthesia must all be considered. Cases of disseminated intestinal tuberculosis are unsuitable, and isolated ulcers only need operation when they are causing stenosis. In general it may be said that the results of operative treatment of tubercular intestinal ulceration are very bad, and that they must be so, since the ulcers are usually multiple. It would be well to limit operative interference, apart from the cases in which stenosis renders it absolutely necessary, to those forms of ileo-caecal tubercular tumour, which are causing motor insufficiency of the intestines. Which operation to choose—extirpation, entero-anastomosis, or enterostomy with the formation of an artificial anus—must be decided after opening the abdomen. Radical extirpation can only be performed if the lung disease is not advanced, the tumour is movable, and not widely spread, the neighbouring lymphatic glands not infected, and the surrounding intestine is not adherent to the tumour.

According to statistics of the St. Hedwig Hospital in Berlin, in 12 cases of ileocaecal tuberculosis 22 radical operations were performed with 7 deaths (25 per cent.). Only twice could the caecum alone be resected; in all the other cases the ascending colon, in four also half the transverse colon, and in three the whole transverse colon, required removal; only three cases had also stricture of the small bowel (Escherbach).

Operative treatment, in spite of advances in surgery, is a very serious proceeding, partly on account of the very bad effects of the narcosis on the diseased lung. Nevertheless, according to the experience of Hofmeister, Kocher, Korte, and others, it is successful in a certain proportion of cases, so that it seems to be indicated if internal treatment fails, if the condition is causing pain, and if the patient desires the operation. But it should be limited to cases of ileocaecal tuberculosis with a good general condition.

Peri-rectal abscesses are to be incised, the contents emptied, and the interior energetically cauterized.

Fistulae remaining after incision or spontaneous rupture, are also to be treated surgically. The position of most anal fistulae in the subcutaneous and submucous tissue renders a superficial incision sufficient, without interference with the sphincter. In 75 per cent. of the cases this leads to healing; and relapses after complete healing are rare after this operation. On the other hand the division of the sphincters, which is necessary for the laying open of deep fistulae, leads to prolonged insufficiency of these muscles, so that the surgical treatment of this form must

be reserved as an *ultima ratio*. Beck's bismuth paste injections are to be especially recommended; they are considerably more successful in fistulae of the soft parts than in those of bone. Ulcers of the rectal mucosa lying near the skin are to be dealt with surgically.

Prophylaxis.

The prophylaxis of intestinal tuberculosis is that of tuberculosis of the whole digestive organs. It includes the prevention both of primary and secondary infections of these organs. It is of particular importance in regard to the disease in childhood, and requires special measures.

The hygiene of the mouth and teeth should be begun in childhood, and must last all through life. The stomach must be protected from repeated injurious actions of a mechanical, toxic, or thermal nature. Rapid eating, insufficient mastication, excessive ingestion of fluids, particularly of an alcoholic nature, over-hot or ice-cold foods and drinks are to be avoided. The bowel should receive its contents in a suitable form, and its peristaltic function should be regulated. Good teeth, a sound stomach, and regular bowels are the best defence against the lodgment of tubercle bacilli in the intestinal tract; they counteract its predisposition to tubercular disease.

In houses, sanatoriums, and cure-resorts in which phthisical patients live, special means (discipline of the cough and expectoration, disinfection of the crockery, table utensils, and glasses) must be taken to diminish the possibility of a deglutition tuberculosis.

Supervision and control of the food-supply, especially of milk and dairy produce, must not be neglected, but must be undertaken officially. Laws dealing with the milk supply should regulate these matters; and must be enforced by competent district and veterinary inspectors. That the meat from tubercular animals, and the milk of cows with tubercular udders, is unfit and dangerous for human consumption is agreed. Efforts at rendering immune our cattle and milch cows are being made. Till such an end is reached sanitary police regulations for the disinfection of tuberculosis among cattle and the prevention of transference of active bovine bacilli to men must be strictly enforced. "Human tuberculosis can never disappear, as long as there is a constant transference of bovine bacilli from animals to men," (Orth).

It is also important to prevent the infection of sound food supplies by human bacilli during transport. To this end phthisical persons should have nothing to do with the supply in

cooking of food, and this is the more necessary as the human bacilli are even more dangerous for the human digestive tract than bovine bacilli. Those working in dairies and the milk trade should therefore be subject to official inspection. The whole subject will be considered in connection with tuberculosis in children.

The prophylaxis of secondary tuberculosis depends on the means of prevention and cure of pulmonary tuberculosis. In cases of open tuberculosis the doctor should repeatedly warn the patient not to swallow the sputum either from ignorance, indolence, or aversion to the sputum flask. It is not a hardship, but in the interests of the patient, that he should be informed of the bad effect of swallowing the sputum on the digestive organs and also on the whole constitution. These prophylactic measures are most important in childhood, and even compulsion must be used.

8. TUBERCULOSIS OF THE PANCREAS.

Anatomical Changes.

A typical miliary tuberculosis, but slightly rich in cells, may appear in the parenchyma or interstitial tissue of the pancreas; the individual tubercles are of the size of a millet or hemp seed, of a whitish yellow colour, they caseate rapidly, and form small cysts and larger cavities. Or there may be tubercular changes in the lymphatic glands, which lie in the pancreatic tissues, while the parenchyma of the pancreas undergoes swelling and sclerosis.

Symptoms and Course.

There are no characteristic symptoms of tuberculosis of the pancreas. Sometimes there may be a hard, slightly nodular swelling, without definite outlines, to be felt. The pancreas is affected secondarily; recent figures show that this occurs not uncommonly in general miliary tuberculosis, and in chronic pulmonary tuberculosis of childhood. The infection may take place through the blood, though the lymphatics, by direct contact, especially from infiltrated and adherent retroperitoneal glands, or from passage of the bacilli up the duct.

Diagnosis.

For the diagnosis the detection of symptoms due to pancreatic disease is important. The most marked of these are glycosuria, imperfect digestion of fats shown by fatty stools, the detection of undigested muscle fibres in the stools, while jaundice is absent.

The differential diagnosis must be made from cancer, sarcoma and gummata of the pancreas, also from cancer of the stomach; the latter causes no pancreatic symptoms, and the mass

does not disappear on inflation of the stomach, like the deeper pancreatic tumour. The age and history of the patient, the growth and mobility of the tumour, and the results of the iodide or tuberculin tests will in many cases lead to a probable diagnosis.

Prognosis. The prognosis is, in spite of the usually chronic course, on the whole unfavourable.

The condition aggravates the primary disease, and may extend to neighbouring organs (duodenum, pleura), or may lead to perforation.

Treatment. In cases of correct diagnosis with a good general condition and slight primary

disease the treatment may be surgical. Our experience is still so slight that no definite indications are possible. The administration of pancreatin for its antibacillary action on the tubercle bacillus does not seem to us to promise well.

7. TUBERCULOSIS OF THE LIVER.

Anatomical Changes. The commonest change produced in the liver by tubercle bacilli is the formation of miliary tubercles, which are generally

small, and difficult to recognize on account of the fatty degeneration of the organ; if the fatty changes are very advanced the tubercles may become absorbed. On account of the growth of surrounding connective tissue an extensive tubercular interstitial hepatitis is produced, which must be considered as an effort towards healing, and plays a part in the production of atrophic cirrhosis. We do not share the opinion of those French writers who consider that hepatic cirrhosis both in the atrophic form of Lacaze and in the hypertrophic form of Hanot is usually of a tubercular origin; and we leave open the question whether the tubercular toxin by itself can produce a specific connective tissue hyperplasia of the liver. An intimate relationship between tuberculosis and hepatic cirrhosis seems, however, undoubted. Also tubercular changes localized in the neighbourhood of the liver may by extension of inflammation lead to connective tissue overgrowth in that organ.

Not rarely the miliary nodules in the liver develop into the size of a pea or hazel-nut; and these nodular tumours may give an impression of metastatic growths. If they enclose small abscesses, the so-called liver cavities, are formed. Of great rarity is solitary and conglomerate tubercle of the liver, i.e., an isolated mass of the size of the fist or larger, which consists of granulation tissue and necrotic nodules, containing epithelioid cells, typical Langhans's giant cells, and tubercle bacilli. It has

been called "*tubercula permagna hepatis*"; and only about seven cases are known. Lastly, tubercular perihepatitis must be mentioned; it is a form of localized dry tubercular peritonitis, occurring on the surface of the liver.

Symptoms and Course.

The symptoms are very indefinite. Icterus is absent, or if it occurs it is due to tubercular glands in the hilus of the liver compressing the bile-ducts. Enlargement of the liver cannot usually be detected; only in the rare cases of the formation of a large nodule will pain and tenderness point to liver disease. More important is the occurrence of urobilinuria and the alimentary leucosuria described by Strauss. As signs of hepatic insufficiency they indicate that the parenchymatous cells of the liver are affected, but do not show whether these changes are themselves tubercular, or are merely the concomitants of tubercular disease elsewhere.

Perihepatitis can be clinically recognized by a friction rub and tenderness on pressure over the liver.

Tuberculosis of the liver according to Orth is never primary; but there are sixteen cases of primary tubercular masses in the liver published. As a secondary affection it is part of the general blood infection in miliary tuberculosis, or may be due to intestinal tuberculosis, in which condition a large number of tubercle bacilli are carried by the portal circulation to the liver. Also infection may occur through the biliary passages. Since in spite of these factors tubercular hepatitis is not common, and gross tubercle in the liver is very rare, the liver must have great powers of resistance to the tubercle bacilli.

Diagnosis.

Since miliary and interstitial tuberculosis is very rarely observed during life, the diagnosis is indefinite. We may determine that the liver is more or less affected and functionless by recognizing the increase of urobilin or urobilinogen in the urine, and by detecting the presence of a levo-rotatory sugar after taking 50 to 100 grm. of levulose. Hildebrandt observed undecolored leucosuria in a case of miliary tuberculosis of the liver from swallowing 50 grm. of levulose.

Levulose is easily detected in the urine if the latter does not contain also grape sugar; the clear urine free from albumen is levo-rotatory, it also gives the reduction tests, and ferments with yeast. If the urine is heated with resorcin and hydrochloric acid, a red coloration and a darker precipitate appear, the latter redissolves with alcohol, giving a redder color. Urobilin can be detected if 2 to 5 drops of a 10 per cent. solution of chloride of zinc are added to the urine, and then an equal amount of ammonium chloride, which redissolves the precipitated oxide of zinc. If

the mixed fluid held in a test-tube against a dark background shows a green fluorescence, urobilin is present.

Urobilinogen can be detected by treating 5 c.c. of urine with 5 to 10 drops of Ehrlich's reagent (diacetylarsulohydroxybenzaldehyde 1 part, hydrochloric acid 20 parts, water 25 parts). If there is much urobilinogen a red colour will be produced in the cold, which with normal urine only appears on heating. The reaction is positive in cases of diffuse cirrhosis and acute passive congestion of the liver, but it not uncommonly fails with cancer of the liver.

The discovery of urobilinogen, urobilin, and leucose taken in conjunction with the other clinical signs may at least lead to a probable diagnosis.

Further difficulty in the differential diagnosis is caused by the fact that tuberculosis of the liver may be a secondary to a gumma, abscess, or other diseases. In cases of tumour of the liver tuberculosis must be thought of, but can only be considered as the primary disease, if other more common conditions can be excluded with certainty.

Prognosis and

Treatment.

Liver clunges appearing during the course of tuberculosis are an unfavourable sign. They mean that the disease is no longer localized, and that the liver has lost its power of resistance and its assimilative functions.

For isolated tubercular liver tumours surgical treatment may be considered, since wedge-shaped resection of the tumour and surrounding part of the liver has given good results. Generally the treatment of liver tuberculosis can only be directed against the primary disease; and as we are almost helpless against general tuberculosis and tubercular ulceration of the bowel, our treatment of secondary infection of the liver must be merely symptomatic.

3. TUBERCULOSIS OF THE GALL-BLADDER.

Anatomical Changes and Symptoms.

Primary tuberculosis of the gall-bladder occurs as a chronic ulcerative cholecystitis, usually as part of an old inflammation, such as an empyema of the gall-bladder due to obstruction by stone. The gall-bladder may also be attacked by tuberculosis secondarily to disease in other organs, especially the lung, or as a part of miliary tuberculosis. The bile-ducts also may be infected by tubercle from the intestinal tract, and by the breakings-down of these tubercles the disease may be carried to the gall-bladder, and produce a circumscribed tubercular necrosis.

The clinical symptoms are not characteristic; they may be

altogether absent, or may be indistinguishable from those produced by cholecystitis, with or without biliary colic.

Diagnosis and Treatment. The bedside diagnosis is hardly ever possible. At the most a progressive and very striking marasmus suggests some serious cause; and a diagnostic laparotomy will then decide whether this is due to cancer or tuberculosis.

The treatment consists in chronic cases in total extirpation of the organ. But there is the danger, even in primary cases, that such an operation may set up an acute military or meningeal tuberculosis. When tuberculosis of the gall-bladder is combined with empyema and gall-stones the double operation of opening and draining, with liver excision, may be considered. This can only be settled for each case separately, after the abdomen has been opened.

9. TUBERCULOSIS OF THE PERITONEUM.

Anatomical Changes. A sharp distinction between tuberculosis of the peritoneum and tubercular peritonitis is not possible, on account of the number of transitional cases. Nevertheless, according to the form of the tubercular infection the pathological picture is different.

When an acute infection takes place through the blood countless military granules appear on both surfaces of the peritoneum, especially in the neighbourhood of the liver and spleen. Since the duration of the disease is very short, acute military tuberculosis of the peritoneum cannot form a large effusion. When there is an effusion it may be serofibrinous, hæmorrhagic, or purulent. Its counterpart is the acute circumscribed tuberculosis of the peritoneum, in which, owing to the previous formation of fibrous tissue, the production of tubercles and caseous nodules is limited to the area between two coils of bowel. Tubercular periduodenitis and perisplenitis also belong to this category.

More common and of more practical importance is the chronic tubercular peritonitis, which becomes gradually diffuse. According to the predominance of fibrous masses or of fluid exudation it may be described as dry or exudative.

In the dry form the coils of bowels in consequence of connective tissue formation are united to each other, and to the other intra-abdominal organs by bands and membranes, and the omentum, as a result of contraction, is converted into a thick, lumpy mass. Different sections of bowels may become cut off or displaced, also quite large pseudo-tumours may be formed.

In the exudative form the amount of fluid is greater than the

plastic exudation. The effusion may be serous, semi-fibrinous, hæmorrhagic, or more rarely purulent, and in different cases may vary from several hundred cubic centimetres to many litres. It may be freely movable, or may be loculated by fibrous adhesions into larger or smaller cysts. The exudate usually contains tubercle bacilli.

If a tubercular intestinal ulcer breaks through into the open peritoneum, each form may become converted into an acute septic peritonitis.

Symptoms and Course.

The acute miliary tuberculosis of the peritoneum owing to its rapid course is but little in evidence, or it is overshadowed by the severity of the general condition. In acute circumscribed tubercular peritonitis there will be spontaneous pain and tenderness over the affected region, usually also interference with the functions of the bowels (diarrhoea or obstruction), and a friction sound.

More characteristic are the symptoms of chronic, diffuse, dry, or exudative peritonitis. They consist of faintness, weakness, a sense of fulness in the abdomen, loss of appetite, pains in the back or abdomen, which come and go, and are seldom sharp, but if so are usually associated with diarrhoea. If an effusion forms the patient himself will often supply the information that in spite of general wasting the abdomen has become larger. Meteorism is a very common symptom in consequence of hindrance to the intestinal peristalsis; more rare are pain on micturition and retching. Vomiting may be due to severe meteorism or to colicky pains, or may be fecal in character if defæcation is obstructed by adhesions and contractions, so that obstruction and flatulent distension are produced. If the abdomen is much distended by fluid or meteorism, dyspnoea may occur. Fever is only rarely absent, but it runs no characteristic course; there are intervals free from fever, and the temperature usually rises higher during menstruation. The pulse is accelerated, also the respiration. The stools are loose; children not rarely have colourless, fatty stools. Jaundice may occur from obstruction to the bile-duct.

The appearance of the abdomen will vary with the predominance of the dry or exudative form, or with the combination of fibrous adhesions and contractions with effusion. In thin children the thickening of the peritoneum can often be felt on pinching up a fold of abdominal wall. In adults there may be diffuse or localized resistance and pseudo-tumour, or if there is free ascites fluctuation will be obtained, which will vary with change of position; encapsuled fluid resembles a cyst. If there

is much fluid resistance and thickening, tumours can no longer be felt; but after the fluid is withdrawn they can be detected, especially the rolled-up and adherent omentum. In other cases in which meteorism is present, when the patient lies on his back there may be a tympanitic note over the whole of the abdomen, or the upper part may be resonant, while the lower and lateral parts are dull on account of the fluid. Or shrinking of the mesentery may cause a clear tympanitic note over the right side, while the left is dull.

Tuberculosis of the peritoneum is a very common disease of the first part of adult life, after forty it becomes rarer. It occurs without any other tubercular disease which can be detected, but such cases do not prove the existence of a primary form, since the original focus may be impossible to discover. Secondary tuberculosis of the peritoneum is due to tubercular ulceration of the bowels, to enlarged mesenteric and retroperitoneal glands, to tuberculosis of the lungs or pleura, or to acute general tuberculosis. Whether in females genital tuberculosis plays a part is keenly discussed; in men infection hardly ever occurs by this route.

The views as to the connection between peritoneal and genital tuberculosis were fully discussed at the last German Gynecological Congress (1913). Kesting upheld the view that when both conditions occur together the peritoneal disease is primary, and that in the genital organs secondary by continuity, or that both infections occurred together from some third source producing a blood infection, and that a generalised peritoneal tuberculosis hardly ever arises from disease in the genital organs. Albrecht considered as a result of 5900 post-mortem examinations, and from clinical examination and animal experiment, that the two conditions were frequently combined, and that either could give rise to the other; in one-third of the anaplasies it could be seen that the genital disease gave rise to diffuse tubercular peritonitis, but that the peritoneal tuberculosis very rarely caused disease of the genital organs; also that in women, much more frequently than in men, a simultaneous infection of both organs through the blood occurs, since, owing to the retroperitoneal position of the female organs, they are more largely supplied by the peritoneal vessels.

Schlimpert in 3,574 autopsies found no case of isolated peritoneal tubercle, and no case of primary isolated genital tubercle. There are no cogent observations to show that peritoneal tuberculosis develops spontaneously out of genital tuberculosis. The peritonium is found affected much more often with severe tuberculosis of other organs.

The course of peritoneal tuberculosis, apart from the acute miliary form and the complications introduced by ileus and perforation, is, as a rule, slow; arrest and improvement, and even spontaneous cure are not rare. It has been computed that untreated peritoneal tuberculosis leads to a fatal issue in 50 per cent. of the cases in one to six months, and in 25 per cent. in six months to five years.

In children, too, tubercular peritonitis may run an acute or chronic course. In about one-third of the cases it begins acutely, and may be mistaken for appendicitis, typhoid, or pneumococcal peritonitis. Ascites in children is usually due to tubercular peritonitis, though hepatic cirrhosis, syphilis, and obliteration of the portal veins must not be forgotten.

Diagnosis.

In spite of the characteristic symptoms the diagnosis is sometimes only made with difficulty. The condition must especially be distinguished from chronic peritonitis of a non-tubercular nature, e.g., from traumatism, cancer of the peritoneum, hepatic cirrhosis, more rarely sarcoma, ovarian cysts, and ascites due to heart, kidney, and infectious disease.

Only a very exact history and a prolonged observation of the case will lead to a correct diagnosis. Experience shows that the large majority of cases of chronic inflammation of the peritoneum are of a tubercular nature, and with the discovery of a tubercular focus elsewhere in the body the diagnosis gains in certainty. Specially indicative of tubercular peritonitis are chronic, variable fever, pains and tenderness, the formation of an effusion, general wasting, and diarrhoea.

On the other hand neither the diazo-urinary reaction, nor a half-moon shaped area of dulness with free ascites, indicate tubercular disease. The tubercular nature of an ascites only becomes certain if tubercle bacilli can be demonstrated in the fluid either bacteriologically or by animal experiment. The latter has the great drawback that the intraperitoneal injections on animals take four to six weeks to give results. The attempts made to shorten this period by means of Bloch's method of injecting the fluid into the subcutaneous tissues of a guinea-pig, the nearest lymphatic glands having been previously forcibly crushed, or by Oppenheimer's modification of injecting the fluid directly into the liver, do not give sufficiently certain results.

In the cases dangerous to life the diagnosis can be quickest made by an exploratory laparotomy; when the pathological changes can be directly inspected, their origin is usually clear. The exploratory operation is the more urgently indicated the greater the probability that the disease is tubercular; since in this case the laparotomy will also be of therapeutic value.

If there is no effusion or exploratory operation is contra-indicated, a diagnostic tuberculin injection may remove doubt. The distinctive focal reaction is characterized by abdominal pain, great feeling of distension, nausea, vomiting, and frequently more or less profuse diarrhoea. For the differential diagnosis

between tubercular peritonitis and cancer; or chronic, non-tubercular affections the tuberculin diagnosis is indispensable.

Easily, it must be noticed that tubercular peritonitis and hepatic cirrhosis not infrequently occur together, according to Seifer in 15 per cent. of the cases. Very often the cirrhosis supervenes on the peritonitis; on the other hand, tubercular peritonitis not uncommonly makes its appearance in the last stage of Laennec's cirrhosis, its development being favoured by the prolonged weakening of the peritoneum from the portal congestion.

Prognosis.

The prognosis of tubercular peritonitis occurring in advanced phthisis is very unfavourable; 46 per cent. die. Also cases with ulcerative disease and purulent peritoneal effusions are of very bad prognosis. On the other hand, a large percentage of cases of dry and exudative peritoneal tuberculosis become permanently cured, if the general condition and the nature of the primary disease allow it. Tubercular peritonitis complicating hepatic cirrhosis runs a very malignant course on account of the small powers of resistance of the patient.

In childhood the prognosis is usually better than in adults; especially the ascitic and fibrous forms do well. Tuberculosis of other organs and mixed infections here again darken the outlook; and the more acute is the commencement the worse the prognosis.

Treatment.

Both surgical and medical methods of treatment may be employed for tubercular peritonitis. So diametrically opposed are the views, that while the Norwegian surgeon Borchgrevink obtained spontaneous healing in 64 per cent. of the cases of tuberculous peritonitis, in the Strassburg clinic Rose observed a death-rate of 61.8 per cent. as a result of conservative treatment, and considers that the operative treatment is "the only effective method of combating a hopeless, or almost hopeless, disease." Both these seem to be extreme opinions, even considering the variable nature of the disease. Frank and others hold the middle view that since surgical treatment leads to good results, one need not be surprised that there are successful cases among those treated on conservative lines.

Surgical treatment consists in opening the abdomen, and removing the fluid through a laparotomy incision; a tubercular vermiform appendix, or a diseased ovary may be removed at the same time. The various theories that have been propounded to account for the good results thus obtained need not be separately

considered, since there is none which covers the whole ground. Probably a reactive hyperæmia and a passage of bactericidal leucocytes into the peritoneal cavity play the chief parts. In any case, the curative effects are undoubted. König first recorded in 1890 131 cases of simple laparotomy with 65 per cent. permanent cures, in 1893 Rüsch published 358 cases with 70 per cent. cures, in 1896 Margarucci 253 cases with 85.4 cures, in 1899 Ebstein 218 cases with 78.8 per cent. cures. The dangers of fistula and hernia after the operation are not great, and relapses are seldom observed.

Zweifel, Rasmann, and others combine insufflation of iodoform into the peritoneum with the laparotomy.

Recently A. Hofmann has recommended painting the pericard and visceral peritoneum with 10 per cent. iodine tincture before performing the incision of the peritoneum. In dry, as well as in ascitic cases, this procedure leads to a hardening of the coats. Bad effects from the iodine or from the absorptions of adhesions have not been observed. The method deserves a further trial.

Compared with laparotomy, puncture of the effusion, followed by washing out with sterilized physiological salt solution, and injections of iodoform (1 to 5 per cent. in emulsion at intervals of four to eight days) is not without danger, and gives poor results; the effusion rapidly returns.

In cases of dry tubercular peritonitis Friedrich has had good results from the artificial production of ascites by means of glycerine injections, which produce a hyperæmia. The injections must take place at increasing intervals. The amount of glycerine is 20 to 25 grm. for children, and 30 to 35 grm. for adults. Erler recommends that a permanent subcutaneous fistula, lined with peritoneum, should be formed.

The medical treatment of tubercular peritonitis must be based on general hygienic and dietetic treatment, and may best be carried out by specific administration of tuberculin (Ganghofner, Fr. Müller, Zoggritz, and others). With this method Birnbaum in Göttingen has obtained such convincing results that tubercular peritonitis need no longer be submitted to operation. In the Breslau clinic, where, on the other hand, all cases are operated on as soon as diagnosed, during convalescence, even six or seven days after the operation, injections of old tuberculin are begun; and Heimann does not hesitate to refer the good results, 54 per cent. permanent cures in women, both to the laparotomy and the tuberculin treatment.

Rest to the body and hyperæmia of the peritoneum may be assisted by Priesnitz's warm or alcoholic compresses; and re-

absorption may be stimulated by injections of mercurial ointment (30 to 60 gr. a day, till salivation commences), and systematic rubbings with soft soap. Constipation must be treated by diet and enemata, diarrhoea also by diet and by astringents, pains by alcoholic compresses and opiates, and meteorism by enemata of camomile. The effects of the internal administration of creosote preparations, of iodides as re-absorbents, of arsenic and iron as tonics, and of cinnamic acid are more than doubtful. On the other hand, it seems that exposures to deeply penetrating Röntgen rays have a good effect in cases that are no longer operable, and this should be always tried.*

The question when medical, and when surgical, treatment is to be used is not easy to answer. It seems certain that tubercular peritonitis of itself seldom causes the death of the patient, and that expectant and operative treatments have about the same mortality. There has been an attempt to distinguish between the two sexes and to recommend the operation more for males, since this is the quickest method of cure, and gives better results in men than in women; on the contrary, the conservative treatment more often causes a cure in women than in men. Each case must be carefully individualized, and from its severity the opinion may be formed how long to persevere with medical treatment, or at what moment an operation is indicated. In any case surgical interference must be avoided if there is active, advancing, primary disease elsewhere, if there is much feebleness or heart weakness, or if the temperature is very high. Every case of tubercular peritonitis should not be at once treated with knife, but only if other means fail. Doerfler correctly says: "We only operate now if, in addition to the ordinary symptoms of chronic peritonitis, there is daily hectic fever, which is weakening the patient, or if the course of an acute tuberculosis is so rapid that the patient retrogresses daily and there is a strong probability of a fatal issue unless energetic means are employed. It is clear that laparotomy must be kept only as a measure in reserve, which may aid the natural tendency of tubercular peritonitis to heal. Accordingly cases of simple, primary, exudative peritonitis, so long as the symptoms indicate that the fluid is merely serous, even if the ascites is abundant, may be treated for weeks, even months, conservatively, careful attention being of course given to the general condition, the amount of strength, and the resistance of the patient."

* The translator has seen very good results in cases of abdominal tuberculosis from direct exposure to the x-ray at a high altitude. The chief disadvantages of this treatment are the length of time required and the expense involved.

It is generally considered that laparotomy is indicated if the effusion is so great as to be dangerous, and is causing much respiratory distress, if it returns after simple puncture, if the effusion is purulent or caseo-purulent, if the bowel is stenosed by inflammatory changes, and if the tubercular peritonitis is accompanied by tumour of the internal genital organs. In all suitable cases the combined general and specific treatment should be first tried, and the operation only performed if these fail. According to Doeffler, Hildebrandt, Thoenes, and others, the operation, to be successful, should not be done too soon; a similar conclusion as has been formed in regard to tubercular pleural effusions. On the other hand, for cases in which internal treatment fails, and in which the fever is hectic and the strength being lost, the operation must not be delayed too long, till the state of the patient makes it hopeless.

There is also a difference of opinion as to the treatment of tubercular peritonitis in children; it is only agreed that the ascitic form should not be punctured. Otherwise there are those who recommend that all cases should be operated on, except quite young children, or if there is generalized or pulmonary tuberculosis. The supporters of the conservative treatment point, not without reason, to the statistics, which show that the prospects of a permanent cure after the operation are not brilliant; and they consider that the operation is quite unnecessary in the fibrous form. We do not take the extreme view that either one or the other method is the only correct treatment for children with tubercular peritonitis. We recommend rather an expectant individual treatment, such as has lately been supported by Cassel. If in spite of suitable general treatment and the use of the proper internal and external remedies for several weeks there is persistent fever, if the swelling of the abdomen does not diminish but rather increases, and if, above all, the child is wasting, conservative treatment will not succeed, and the operation should be done, whatever form the peritoneal tuberculosis presents. After the operation an attempt should be made to cure the peritoneal condition, as well as the latent or manifest primary tubercular focus, by a systematic tuberculin treatment. This is especially important with children to ensure a permanent result.

10. TUBERCULOSIS OF HERNIAL SACS.

Anatomical Changes.

Tuberculosis may appear as miliary, nodular or diffuse thickenings of the hernial sac, more rarely of the hernial contents. It attacks especially the neck and the bottom of the sac. In recent hernias the tubercular process accompanies ascites.

**Symptoms and
Course.**

Tuberculosis of the hernial sac causes periodic attacks of pain in the abdomen. It progresses gradually, and appears chiefly in male patients, and especially in children. It is nearly always secondary, but a primary disease is possible. It is associated with tuberculosis of the peritoneum, the mesenteric glands, the epididymis, and especially the bowel.

Diagnosis.

The diagnosis is particularly difficult with adherent and irreducible hernias. The existence of intestinal or peritoneal tuberculosis, the detection of fluid, which according to the position of the body occupies the abdomen or the hernial sac, and a tenderness and unevenness of the hernial sac, may give rise to a suspicion of the condition. But generally it is first found at an operation.

**Prognosis and
Treatment.**

The prognosis is favourable; and the treatment is surgical, especially if there are symptoms of incarceration. The operation also allows the emptying of the ascites, and the removal of the tubercular tissue in the sac of the hernia.

CHAPTER VI.

Tuberculosis of the Urogenital Organs.

According to the very extensive statistics of Posner, Heiberg, Saxtorph, and others, urogenital tuberculosis is found in 4 to 5 per cent. of all autopsies. It may appear at any age, but particularly between 20 to 35, the time of the greatest sexual activity. In an overwhelmingly large proportion of cases it is a secondary disease. There are a sufficient number of cases of primary hæmatogenous infection to show that this, without doubt, sometimes occurs. On the other hand, it must be remembered that latent tubercular foci are only discovered with difficulty, and also that an apparently healed deposit may give rise to a virulent infection. The propagation of urogenital tuberculosis usually takes place in a descending direction, following the course of the physiological secretions.

Although the statistics give the frequency of tuberculosis of the urinary and genital organs together, yet either system may be affected separately; it is agreed that in men the combined urogenital tuberculosis predominates, while in women tuberculosis of the urinary occurs much less frequently than that of the genital organs. The anatomical arrangement in the two sexes accounts for this; in men the urethra serving as the excretory duct both for the urinary and sexual organs, it is obvious that disease of one system easily spreads to the other; while in women both systems are anatomically distinct. Although it is now understood that an isolated tuberculosis of most of the organs of the urogenital apparatus hardly ever occurs as a separate clinical disease, especially in men, yet each organ must be separately considered for the proper understanding of the mode of infection and propagation of the disease, and not least for the consideration of the treatment. Tuberculosis of the urinary organs of

women may be considered with that of men, since the conditions in the two sexes correspond; but the tuberculosis of the female genital organs must be separately treated.

Tubercular affections of the external genitals need not be further considered. Tubercular granulations and ulcerations, and also lupus, have been observed both on the penis and scrotum and on the labia of the vulva. They are generally a secondary condition.

A. Urogenital Tuberculosis of Men.

1. TUBERCULOSIS OF THE URETHRA.

Anatomical Changes.

Tuberculosis of the urethra follows the usual course of the disease in mucous membranes. The early stage has been but little observed, and has only been accidentally discovered as a complication. All forms of mucous membrane tuberculosis have been observed, from single tubercles and slight granulations to the severest ulcerations and raising and necrotic nodules. Its usual sites are the most anterior and posterior portions of the tube, it is very rare in the membranous part and commonest in the prostatic urethra. An affection of the anterior urethra is relatively uncommon, and is usually slight, while the severe forms of the disease are situated in the posterior part and its annexæ, since the anatomical arrangement is here most favourable to the lodgment and development of the bacilli. The disease in the posterior part is relatively frequent and is hardly ever absent in cases of long standing urogenital tuberculosis. It is usually combined with tuberculosis of the prostate, the vesiculae seminales and the ejaculatory ducts, as may easily be understood on anatomical and physiological grounds.

Symptoms and Course.

The clinical symptoms are pains on micturition, a purulent discharge, bleeding from the urethra, and later stricture. The disease may heal spontaneously, thus giving rise to a stricture, which is usually situated in the anterior urethra. The disease in the posterior part takes the form of advancing ulceration, with the formation of abscesses and fistulae. These occur especially about Cowper's and Littré's glands, and have a therapeutic importance.

The question whether there is a form of primary urethral tuberculosis cannot be answered with certainty; there is no undoubted case recorded. But since in treatises on tuberculosis one finds the assertion that pulmonary tuberculosis may be caused

by infection during oral coitus, the theoretical possibility of a primary urethral tuberculosis, as a consequence of normal connection with an individual suffering from genital tuberculosis, must be admitted for both sexes. A secondary infection from another tubercular nodule somewhere in the body is naturally much more common. The anatomical position of the prostatic urethra, with its numerous glands, explains why it is frequently affected by bacilli from the kidneys, the testicles and vesiculae seminales. Although it is possible for tubercular disease to spread by continuity from the prostate or seminal vesicles into the posterior urethra, yet the reverse occurs much more often. Spread of disease from the posterior urethra to the neighbouring organs results in extensive destruction with the formation of large cavities, so that it joins together with disease in the prostate and vesiculae seminales.

Diagnosis.

The recognition of urethral tuberculosis is easy if tubercle bacilli can be discovered in the secretion. The staining differences between the tubercle bacillus and the rather straighter and thicker smegma bacillus are not absolute, but though the latter bacillus is fast to acids it is not usually so to alcohol and acids.

A. Weber recommends the following staining method as a means of differentiation. Stain in carbol fuchsin, decolorise for ten minutes in absolute alcohol or, hydrochloric acid 5 parts. Counter stain with a half dilution of alcoholic methylene blue solution. The smegma bacilli will be decolorised. The antiformin method also distinguishes between the two bacilli, since antiformin destroys the smegma bacillus; that is to say, its acid-fast membrane.

The culture of smegma bacilli has up to now not succeeded. According to C. Fraenkel, the supposed growth of smegma bacilli obtained by Lauer and Czaplewski were really pseudotubercular bacilli, which nearly always are present in smegma.

N.B. For examination of the urine for tubercle bacilli, as an aid to the diagnosis of tuberculosis of the genito-urinary tract both in men and women, it is better that the sample should be obtained with the catheter, so that under suitable precautions confusion with smegma bacilli is prevented.

If tubercle bacilli cannot be detected the disease must be distinguished from gonorrhoea, with which it has a great resemblance. Sounding for stricture is of some value. But it must be here mentioned that gonorrhoea plays a prominent predisposing part for the various forms of urogenital tuberculosis. The urethroscope gives the surest information by which quite early tubercular granulations and ulcerations may be diagnosed in the anterior or posterior urethra; and it is also of great value for treatment.

Prognosis.

Spontaneous healing has certainly been observed; so that the prognosis of uncomplicated cases is by no means unfavourable. Much depends on the early recognition and treatment of the disease; for both of which purposes the urethroscope is most useful. If there are complications and disease of other organs the prognosis of course is not so good.

Treatment.

The treatment of disease of the anterior part of the urethra must be analogous to that for gonorrhœa, when the disease cannot be radically treated by scraping. The resulting stricture can be treated in the usual manner.

The local treatment of disease of the posterior urethra consists of instillations of weak sublimate solution, iodoform emulsions, or ichthyol, or careful washing out with disinfecting or astringent solutions may be performed. The passage of the instruments, since all treatment must be external, must be very carefully performed to avoid a spread of the tuberculosis or a secondary infection. A most careful asepsis is essential. The advice of a specialist should be always sought. With these local measures the general treatment must be joined. Consideration must be paid to complications.

2. TUBERCULOSIS OF THE PROSTATE.**Anatomical
Changes.**

The affection of the prostate by miliary tuberculosis needs no special description. The chronic forms begin in one of the lateral lobes or in the urethral part of the prostate as separate nodules, which may coalesce and form a mass the size of a hazelnut. This may either undergo fibrous changes, or may caseate and necrose. Even abscesses by reabsorption or by discharge may come to a standstill, and heal by fibrous encapsulation. Progressive disease may lead to caseous infiltration of the one lobe of the prostate, or even of the whole organ, which on breaking down forms a large cavity involving neighbouring structures.

**Symptoms and
Course.**

The early stages of tuberculosis of the prostate cause only slight, or even no, local or general symptoms; enlargement of the gland from congestion, infiltration and softening are shown by feelings of pressure and pain, especially on defecation and micturition, by frequent micturition, and later by a purulent discharge with blood in the secretion and in the urine.

Primary disease as a sole localization of tuberculosis is only seldom found. Usually it is secondary, and occurs quite

frequently in the course of urogenital tuberculosis. The prostate being traversed both by the urethra and the ejaculatory ducts bacilli may reach the gland either from the kidneys or the testicles. The glandular tissue offers the bacilli a very favourable breeding ground, so that progressive, destructive changes are often met with. A gonorrhoeal infection particularly predisposes the prostate to tuberculosis, a point important both for prophylaxis and therapeutics.

In severe disease of the urogenital tract the prostate plays an important part; caseous necrosis and abscess formation lead to the appearance of cavities; the necrosis may spread to the neck of the bladder, and communication may form with the bladder; the disease may also spread to the membranous urethra and destroy it. The cavity filled with urine and pus may undergo secondary infection, and the septic changes may spread to the rectum and pelvic connective tissue. Miliary tuberculosis is observed relatively frequently.

Diagnosis.

Prostatic tuberculosis leads quite early to an enlargement of the organ, which can be felt by the finger in the rectum. In the same way the nodules and areas of softening may be recognized. By the urethroscope quite early in the disease secretion from the glands can be recognized; this may be facilitated if necessary by pressure from the rectum. If the bacilli cannot be detected the condition must be separated from chronic prostatitis, probably due to gonorrhoea. There is no difficulty in recognizing advanced disease of the prostate.

Prognosis.

Although spontaneous healing has been observed, even after caseation and abscess formation have occurred, and although the permanent results from proper treatment are often good, yet the prognosis is always serious. This depends on the virulence of the bacilli, the extent of the process, the tendency to spread, and the frequency of secondary infection.

Treatment.

Since the disease is practically always secondary the removal of the primary mischief is the chief thing, without which no treatment can give good results. A local non-surgical treatment must therefore be carried out in all cases after the operative removal of the primary disease; it is usually associated with the measures required for urethral tuberculosis. The chief point is to limit as far as possible the disease to the prostate. Prophylactic measures after gonorrhoea in phthisical patients, or persons predisposed by heredity, are of importance.

Surgical treatment comprises prostatotomy, opening the prostate, opening abscesses, and dividing or extirpating fistulae and excision of Cowper's glands. All these operations require hospital treatment. Complete healing is rare; usually a fistula is left.

3. TUBERCULOSIS OF THE VESICULÆ SEMINALES.

Anatomical Changes.

The disease begins as single or disseminated tubercular nodules, which may lead to connective tissue formation, or if the disease advances to necrosis and abscess formation, or not so frequently to caseation. This form of the disease has a marked tendency to connective tissue contraction. Complete obliteration of the seminal vesicle with fibrous destruction of the duct has been observed.

Symptoms and Course.

The clinical symptoms are only slight, and are often absent in the early stages; only when an abscess forms are severe radiating pains and feelings of pressure produced, especially on defecation or micturition.

Primary tuberculosis of the vesiculæ seminales has been rarely observed, in this case the infection has occurred through the blood. The disease is much more often secondary to mischief in the prostate or epididymis. It is usually bilateral; and has a greater tendency to heal in this position than in any other organ of the urogenital system. If the disease is progressive and leads to an abscess, the infection never spreads by means of the ejaculatory duct to the urethra, but extends directly into the prostate. The upper part of the vas deferens may also become affected, but an extension to the epididymis has never been observed.

Diagnosis.

In the absence of complications the diagnosis is difficult, in more advanced cases it may be made by rectal examination. The tense and tender vesicle can be felt; and it has a doughy consistency on account of the purulent and caseous contents.

Prognosis.

On account of the great tendency to heal disease in this position is not so unfavourable as in the prostate. But as in most cases it is a secondary affection, the prognosis largely depends upon the nature of the primary disease.

Treatment.

The treatment of prostatic tuberculosis is in many respects suitable for disease of the seminal vesicles, since as a rule the whole region is affected

together. Since in many cases injection of iodoform emulsion into the vas deferens has given good results, this method may form a part of the surgical treatment. If the case is not improving castration with extirpation of the vesicula and vas deferens may be considered. There are no reports as to the results of tuberculin treatment; Casper considers that it should be tried before surgical measures are resorted to.

4. TUBERCULOSIS OF THE TESTICLE, THE EPIDIDYMIS, AND THE VAS DEFERENS.

Anatomical Changes.

Tuberculosis of the sexual gland usually begins in the epididymis in the form of one or more isolated firm nodules. The disease may remain stationary for a long time, or may lead to caseous infiltration of the whole organ. Also miliary tubercles may form in the testicle; they sometimes caseate, and like necrosing nodules in the epididymis usually discharge externally, leaving a fistula. The vas deferens is affected more frequently than the testicle, usually at the same time as the epididymis. The disease is not continuous, but appears in the form of single isolated nodules with healthy duct between. The nodules usually consist of a hard, infiltrated zone surrounding a caseous centre.

Symptoms and Course.

The disease manifests itself clinically by a swelling of the epididymis, sometimes of the testicle, usually accompanied by more or less severe pains radiating up towards the groin. But swelling may occur entirely without symptoms; and the discharge of caseous nodules in soft, crumbling masses may occur without special pains. The fistula may last for months, even years, and apart from occasional exacerbations may cause no symptoms. When the disease spreads to the vas deferens the thickened, beaded tube can be felt, which is but slightly sensitive to pressure. The disease is usually limited to the lower part of the vas, the opposite to what is found when the infection spreads from the seminal vesicles. Further complications are secondary disease of the prostate and the seminal vesicles, and later of the urethra and the bladder. An ascending infection of the kidney is never observed.

Tuberculosis of the sexual gland is a common disease; it is more often unilateral than bilateral, and in many cases is a primary disease, the infection doubtless occurring through the blood. According to Virchow it always begins in the epididymis, where the windings of the tube offer a favourable point of lodge-

ment to the bacilli. In small children primary nodules are more often found in the testicle; according to Kraemer they are congenital. The disease may set up tubercular peritonitis through an open processus vaginalis, by infection of the lymphatics; also lymphatic infection of the opposite gland is the rule. Traumas and inflammations, especially gonorrhoea in an individual with hereditary tendencies, are predisposing causes. Sexual power may be long retained.

Diagnosis.

The disease may be difficult to diagnose in its closed stages. The slight pain, and the craggy, nodular condition of the affected part are characteristic. Acute orchitis and epididymitis are very painful, and cannot be mistaken for tuberculosis. Chronic inflammatory conditions are more difficult to distinguish, and demand a very careful history and examination of the whole urogenital system and the rest of the body. An important point is that tuberculosis nearly always begins in the epididymis, while syphilitic disease of the epididymis alone is very rare. Gummatous nodules are situated in the testicle, they are but little tender on pressure, and may soften; also syphilitic disease is usually bilateral, and more often causes inflammatory changes and adhesions in the vas deferens. Test tuberculin injections may make the diagnosis certain by producing focal symptoms, such as dragging pains up the vas, tenderness, pain and swelling, and even suppuration in a diseased nodule.

Prognosis.

Spontaneous healing has been seen, even caseous nodules, which have discharged and emptied themselves, have become permanently healed without aid after a longer or shorter time. The results of conservation and surgical treatment are very good, so that the prognosis on the whole is favourable. Extension to other organs does not often occur under proper treatment. On the other hand, after years of arrest, relapses and softening have been observed, and it cannot be denied that miliary tubercle quite often arises from disease of these glands.

Treatment.

The opinions of surgeons as to the necessity of castration are by no means in agreement. Those who are in favour of the operation say that in 50 to 60 per cent. of the cases it leads to cure. Their opponents limit themselves to the enucleation of diseased nodules combined with general hygienic and dietetic treatment, especially sea and sun baths. The possibility of the spread of tuberculosis must be considered. At the commencement of the disease a conservative treatment seems indicated. If this does not succeed, a uni- or

bilateral castration with extensive resection of the vas and possibly also of the vesiculæ seminales must be undertaken.

In children the conservative treatment is usually recommended. In adults, too, it should take the first place, especially if the tuberculin treatment is employed, the curative action of which in tuberculosis of the testicle and epididymis is undoubted.

5. TUBERCULOSIS OF THE URINARY BLADDER.

Anatomical Changes.

Tuberculosis of the bladder usually begins in the mucous membrane of the base in the neighbourhood of the trigone, close to one of the orifices of the ureters, as grey-red isolated granules with narrow red edges. These join together, cavitate, necrose, and result in eroded ulcers with sharp and swollen edges. These small ulcers may also join together and become very extensive; however, they usually remain limited to the mucosa. So long as the ulceration is purely tubercular, tubercular granules will always be found near their edges. As a result of secondary septic infection the ulcers may gradually lose their tubercular character, and a severe inflammatory cystitis supervenes.

Symptoms and Course.

The initial eruption of tubercles causes practically no symptoms. When ulcers form an early hæmaturia may occur. The bladder is tender on pressure, and there are often spontaneous pains. The urine at first is clear and acid; later it contains blood and pus with tubercle bacilli. If the ulceration becomes more extensive there will be frequent micturition with very painful spasms of the bladder. Very characteristic, too, is the intolerance of the bladder to washing out. Advanced tubercular disease with the secondary inflammatory changes lead to inflammation of the deeper coats of the bladder and to interstitial contraction. The wall of the bladder becomes thickened, and the cavity much diminished. Passage of urine is then extremely painful, and incontinence is often present. Marked cystitis is accompanied with ammoniacal decomposition of the urine, giving it a putrid odour.

Tuberculosis of the bladder is a very common disease. Its production depends upon some original primary disease. Not all the bladders through which tubercle bacilli pass become tubercular, so that a certain predisposition is necessary. Among predisposing causes are gonorrhœa, especially when it affects the bladder, traumatism, congestion, and retention of urine, particularly in individuals with an hereditary tendency. The

occurrence of primary tuberculosis of the bladder has never been for certain observed. The secondary disease is usually a consequence of infection of the kidney. It is noticeable that the disease usually begins near the orifice of the ureter. Infection from the sexual organs more rarely occurs, in that case the disease commences near the internal orifice of the urethra. Extension of the tubercular disease towards the testicles according to recent observations never occurs, and that into the prostates and kidneys is very rare, and only occurs under special conditions, such as retention of urine.

Diagnosis.

Since tuberculosis of the bladder is usually secondary to a primary focus in the kidney detection of tubercle bacilli in catheter urine is not conclusive, since they may originate in the kidney. The same may be said for blood or pus in the urine. On the other hand, bacilli may not be found; it has been stated by Casper that in tubercular disease of the bladder bacilli can often not be detected, and that the absence of all bacteria in the urine from a case of cystitis is very suspicious of tuberculosis. The absence of all other causes of cystitis is also of considerable diagnostic importance. As a last resource animal experiments are of service.

For the recognition of advanced cases the obvious clinical signs are sufficient. The earliest possible diagnosis can be made by the cystoscope, by means of which the first deposit of tubercle round the mouth of the ureter can be detected, before any clinical symptoms are produced. According to Frank the earliest sign of disease of the bladder, even before the formation of tubercles, is that the orifice is no longer smooth and round, but is angularly distorted and funnel-shaped. This may either be a sign of simple chronic inflammation, due to purulent urine from an affected kidney, or of tuberculosis of the ureter. On the expediency of cystoscopy in tuberculosis of the bladder opinions are not agreed. In skilled hands all injurious effects may be avoided, and full use may be made of this valuable means of early diagnosis.

The tuberculin test may be valuable by producing focal symptoms, such as painful and frequent micturition, and pains in the region of the bladder.

Persistent catarrh of the bladder may be distinguished by the effect of treatment. Stone in the bladder can usually be easily recognized. Cancer of the bladder in its early stages causes most confusion if it occurs in a patient in middle life, and takes the form of an infiltration and not of a tumour. The microscopic examination of portions of tissue, and the further course of the disease will clinch the diagnosis.

Prognosis.

Since the condition is secondary the prognosis to a large degree depends upon the primary disease in the kidneys or testicles. If this assumes a favourable form, the prognosis of the bladder disease, especially in initial cases, will also be favourable.

Treatment.

The non-surgical treatment aims rather at a mitigation of the symptoms by general measures, than at curing the disease itself.

Spasms and pains may be relieved by warmth in various forms, baths, hot sitz-baths, hot compresses, &c. Narcotics frequently cannot be avoided; of these opium in a suppository or subcutaneously is most serviceable, not only on account of the relief of pain, but also of the sedative effect on the bladder. After the narcotics belladonna is the most useful drug. The combination of narcotics with pyramidon (4 to 7 gr.) or antipyrin (7 to 15 gr.) in suppository or enema with hot water has been much recommended. Antipyretics alone have a sedative effect on the bladder, only if necessary large doses of 25 to 50 gr. of antipyrin or 5 to 15 gr. of pyramidon must be used in a hot enema.

Many authorities altogether refuse to employ local treatment for vesical tuberculosis. This is partly due to the extreme sensitiveness of the diseased bladder to manipulations, and the consequent painfulness of such treatment. There is nearly always a marked intolerance against washing out the bladder. Therefore one is usually limited to the instillations recommended by Guyon into the posterior urethra. According to Casper weak solutions succeed better than the concentrated instillations, only the introduction must be carefully performed with a syringe and soft catheter; 5 to 10 c.c. of the solution are often sufficient, and never more than 50 c.c. are to be used. He recommends first the introduction of 5 c.c. of a guaiacol and iodoform emulsion (guaiacol 5 parts, iodoform .5 to 5, and sterilized olive oil to 100 parts). The instillation of lactic acid solution (up to 20 per cent.) is, according to him, very useful, but it is so extremely painful that he has ceased to employ it. As the principal remedy for vesical tuberculosis use has been made of sublimate, at first as instillations of 1 in 20,000 to 1 in 1,000, and as the spasms and pain diminish in increased quantities (5, 10, 50 c.c.), and weaker solutions of 1 in 10,000 to 1 in 5,000, once, or at most, twice a week. The fluid should remain in the bladder as long as the patient can bear it without great pain. Each application of the sublimate is followed by a painful reaction, so that it has been advised to keep the patient under morphia for one or two days. Carbolic acid had also been used in increasing quantities of 5 to

30 c.c. of 1 to 5 per cent. solution, with good results, but it is excessively painful.

Careful general treatment is necessary in this, as in all forms of urogenital tuberculosis. The beneficial effects of warm southern climates on the subjective symptoms has been often noticed. Creosote, guaiacol and ichthyol have been used internally, but the curative action of these drugs is not proved. Diuretic waters and large quantities of milk may be recommended. On account of their antibacterial action on the urine urotropin, helminol, formotropin, salol, potassium chlorate, camphoric acid, and salicyl have been given, but they have no action on purely tubercular cystitis.

If these measures fail, and if there are no contra-indications in the form of the primary disease, the general condition or the presence of other complications, then surgical treatment may be considered, upon which a final opinion cannot yet be pronounced. The results will depend upon which organ is the seat of the primary disease. Only after radical removal of this has surgical treatment of vesical tuberculosis a chance of bringing about a cure. After extirpation of the kidney spontaneous healing of tubercular disease of the bladder has been often observed, so that when possible this operation must take the first place after the general and tuberculin treatments. Barth found, with his successful operative cases of tuberculosis of the kidney and bladder after complete healing of the vesical ulceration, that though spasms and pain on micturition disappeared yet urgent micturition frequently lasted for years in spite of all treatment; therefore he recommends early nephrectomy before infection of the bladder occurs. Surgical treatment of tuberculosis of the bladder consists of opening the bladder from the perineum or hypogastrium, removing, scraping, or cauterizing the diseased areas, and draining. It has often given good results.

If the bladder is infected from the genital organs the operation is more difficult, and the results more uncertain. After the removal of the tubercular nodules in the testicle, the surgical treatment of the disease of the prostate and its surroundings comes into question. Also the disease in the neck of the bladder is liable to be very severe. But if complete healing cannot be brought about, even after the secondary operations which are often necessary, the surgical treatment will frequently cause a marked improvement of the severe pains.

Lately remarkable results have been achieved with tuberculin treatment, so that it is being more and more recommended by those in a position to judge, especially after removal of the affected kidney.

6. TUBERCULOSIS OF THE KIDNEY AND URETER.

Besides the specific tuberculosis of the kidney toxic affections often appear during the course of chronic phthisis. Such is the albuminuria, which frequently occurs from irritation of the kidney fiber produced by the toxins of the tubercle bacillus circulating in the blood. It consists of a simple albuminuria without formed elements from the kidney being present. In this it differs from the rarer febrile albuminuria occurring during phthisis, which is chiefly observed with mixed infection, and only causes a slight amount of albumin in the urine. Lately the opinion has gained ground that tuberculosis is a very fertile cause of chronic parenchymatous nephritis. Lastly in the cachectic stage of phthisis, especially if complicated with intestinal tuberculosis, amyloid degeneration of the kidney may appear. It generally goes with chronic parenchymatous or interstitial nephritis, so that the opinions of authors as to its symptoms differ. Usually the amount of albumin is rather diminished, and it frequently fluctuates. The urine is clear, of a light citron colour, and acid. Abundant albumin with scanty sediment is characteristic. General dropsy is very frequently present. Changes in the circulatory apparatus only exceptionally occur, absence of cardiac hypertrophy is almost symptomatic. Signs of amyloid disease in the liver, spleen, and bowel can often be detected.

The treatment is dietetic, and must depend on the original cause. Of drugs iodides, iron, arsenic and quinine, alone or in combination have been most used.

Anatomical Changes.

Miliary tuberculosis may occur in the kidney, where it produces no special symptoms. The chronic localized form begins, according to Israel, as a single nodule in one kidney, usually at one pole, more often the lower, at the junction of cortex and medulla. The initial tubercular foci multiply, join together, caseate, and necrose, and form a hollow cavity. In other cases the disease begins as a tubercular ulcer on one of the papillae of the pelvis of the kidney. The caseous infiltration on its spread involves first the medulla and papillae of the kidney, so that by necrosis an irregular cavity containing bands of parenchymatous tissue with eroded walls is formed, which in advanced cases takes the form of a single cavity, partly filled with caseous material. When the cortex of the kidney is similarly involved only a much enlarged sac, with a thickened fibrous capsule, is left.

The softened caseous masses are discharged in the urine, and set up ulceration and caseous infiltration of the pelvis of the kidney, and the ureter. In consequence of blocking of the

ureters by caseous material the urine will be obstructed, and the pelvis and ureter will become dilated. The walls of the ureter are not at first uniformly affected, but present a series of isolated nodules like the condition of the vas deferens. In advanced disease it is converted into a stiff tube, with cylindrical areas of excavation between firm, nodular infiltrations. In rare cases of advanced destruction of the kidney there may be complete obstruction of urine.

Isolated tuberculosis of the ureter is not met with.

Symptoms and Course.

The initial disease causes no diagnostic symptoms. Inflammatory hyperæmia, causing swelling of the kidney, and stretching of the capsule, will evoke as early symptoms a feeling of weight in the kidney region, and pains, which may develop into attacks of colic, accompanied by vomiting. Bodily movements of various kinds may bring them on. The pains frequently extend down the ureter towards the bladder. The region of the kidney and ureter are usually tender on pressure. In early stages an enlargement of the kidney can frequently be detected on palpation. Precipitate micturition occurs frequently at night from reflex irritation; in early cases the amount of urine is usually increased.

The alterations of the urine are important. The urine, which was at first clear, frequently contains blood, sometimes in profuse amounts, especially in ulceration of the papillæ or pelvis. Only after the breaking down and discharge of a caseous nodule will the urine become thick, from the contained pus and caseous debris. The amount of albumin will depend on the amount of nephritic changes in the diseased kidney. In the sediment round cells, transitional epithelium from the urinary passages, free granules, caseous and fatty debris, elastic fibres, phosphates, and tubercle bacilli, sometimes in characteristic plants, can be recognized. The detection of the bacilli may be very difficult, and frequently first succeeds by experiments on animals. In cases of mixed infection streptococci may be found.

The general health of the patient may remain for a long time unaffected. Fever and loss of weight may be absent. The differences in the course of the disease depend on the acuteness of the process and the way in which it spreads. Only in advanced cases do we meet with general symptoms, fever, affections of the bladder, the sexual and other organs, hydro- and pyonephrosis, perinephritic abscess, or intestinal, vesical, and vaginal fistulæ.

Tuberculosis of the kidney practically always depends upon

the presence of another tubercular focus somewhere in the body. It is the most common form of urogenital tuberculosis, and according to recent researches it is the initial form which hæmatogenous infection of this system takes. Ascending disease from the bladder and the lower parts of the urogenital system is much rarer; it may occur either from tubercle bacilli ascending the ureter in consequence of urinary stasis from obliterative ureteral infiltration, or from antiperistaltic contractions of the ureter (Wildbolz), or in the lymphatic system of the wall of the ureter. In quite half the cases the disease is unilateral, a very important fact. The disease of the second kidney may occur in consequence of infection through the blood, exceptionally even in an early stage of the disease of the first organ. As to the duration of the disease, its frequency, its predilection for either sex, and other questions the figures are not in accord. Barth considers that the kidney is relatively frequently affected during pregnancy and the puerperium, on account of the hyperæmia and congestion of the organ which then occurs; and he recommends that patients with pyuria at those times should be examined for renal tuberculosis.

Diagnosis. The difficulty lies less in detecting the disease as such, than in determining which

kidney is affected. The surest means of recognizing the disease is the discovery of tubercle bacilli in urine obtained by the ureteral catheter; but it must be noted that phthisical patients with sound kidneys sometimes eliminate the bacilli circulating in the blood through the urine; this accounts for the fact that B. Bertier by inoculating the centrifugalized deposit of the urine from advanced phthisical patients into guinea-pigs obtained positive results in 33 per cent. of cases. If the urine is taken only from the bladder, tuberculosis of that organ must be excluded; cystoscopy is most useful for this purpose. Its use for the early diagnosis of vesical tuberculosis has already been mentioned; by its help the condition of the orifices of the ureters and their functions may be directly examined, and it is also valuable for treatment. In disease of the kidneys and ureters their peristaltic contractions are weakened; frequently the flow of turbid urine from the affected side can be directly observed; and often the ureteral papilla is characteristically inflamed, being swollen, distorted, very vascular, and even hæmorrhagic, or ulcerated. By the use of the ureteral catheterism introduced by Casper the function of the kidneys can be examined separately. The functional activity of the two kidneys can be determined by the following methods: (1) by the estimation of the freezing point of the urine from the two kidneys; (2) by the phloridzin test

worked out by Casper, for comparing the power of sugar excretion of both kidneys after taking phloridzin; (3) by the indigo-carmin test of Völcker and Joseph; (4) by a similar test with methylene blue; and (5) by the diastase estimation of Wohlgemuth. The phloridzin test gives no reliable information in early stages. The indigo-carmin test has given the best results in Bier's clinic.

To accelerate the appearance of the coloration in the urine obtained by ureteral catheterization, it is recommended to allow the patient to become thirsty and to inject the indigo-carmin intramuscularly. Under normal conditions, after about five minutes, the first drop of bluish urine occurs; after about ten minutes the colour is deeper. In *pyelitic* patients an amount of the prolonged absorption of pigment (there is a delay) in febrile patients there is a definite acceleration of the reaction. If the coloured urine does not flow out of the ureter, the kidney is diseased. If only slight tubercular disease of the kidney is present the excretion of the pigment may be unaltered.

The method is not applicable if in consequence of tuberculosis of the bladder the mouth of the ureter cannot be seen, and therefore the ureteral catheter cannot be passed, and when polyuria, as a consequence of catheterism, interferes with the test (Joseph).

Without the aid of cystoscopy and the ureteral catheter one has to be guided only by the clinical symptoms and the results of urinary analysis, so that the diagnosis becomes difficult, and the early diagnosis especially is often impossible. If an enlargement in the size of one kidney can be detected one must consider whether it is a compensatory hypertrophy of a sound organ. If there is obstruction to the flow of urine the tubercular focus may be completely shut off, and may entirely escape recognition without the use of the cystoscope and ureteral catheter.

In all doubtful cases the diagnosis by tuberculin, properly employed, may give most useful information by producing a local reaction (renal pain and bleeding).

Also the Röntgen-rays sometimes are very serviceable. For the perfection of the radiographic diagnosis of renal tuberculosis, according to v. Lichtenberg and Dietler, the so-called "pyelography" is to be recommended, that is the X-ray examination of the pelvis of the kidney filled with 10 per cent. collargol solution. Doubtful cases can be certainly diagnosed in this way, and in cases already diagnosed bacteriologically the pathological condition can be more completely recognized from the characteristic appearance of the more or less destroyed kidney and the changes in the ureters.

Under certain conditions the extraperitoneal exploration of the organ, splitting the capsule, and, if necessary, the kidney, even up to the pelvis, may be employed; which by many surgeons is preferred to a difficult catheterization of the ureters, particularly

when the bladder is infected (Krabbel). The best authorities on this disease are adopting the recommendation of Roosing of regularly exploring both kidneys, and, indeed, first that organ which seems to be most healthy.

The differential diagnosis must be made from tumour and stone of the kidney and pyonephrosis. Malignant tumours usually appear later in life, and as a rule do not cause suppuration. Stone may be recognized by the frequent colic and the crystalline deposit in the urine. Both these diseases are usually free from fever. In the radiographic examination a distinction must be made between a stone and a calcifying tubercular nodule in the kidney. Tuberculin may here, too, help in the diagnosis, and the more as a renal calculus may be associated with tuberculosis. More difficult is the distinction between pyonephrosis and tuberculosis of the kidney, especially if the pelvis. Daily bacteriological examination, and repeated inoculation experiments on animals, of the urinary sediment may be required to determine the presence or absence of tuberculosis. In all cases this is associated with some other tubercular focus in the body, and both conditions may be revealed by a subcutaneous tuberculin injection. As the early diagnosis of renal tuberculosis is so extremely important for treatment all diagnostic methods may be required.

Prognosis.

Spontaneous healing of renal tuberculosis has not been observed for certain, but it is believed that small nodules may heal of themselves occasionally. Under symptomatic treatment B. Eichhorst saw several cases so far improved as to become free from clinical symptoms. The course of cases treated conservatively is usually very long, often extending over many years, till renal insufficiency or some other complication brings about the end. In bilateral disease the prognosis is naturally much worse. Operative treatment brings about complete healing in something like 50 per cent. of the cases; the results of Israel with 63.8 per cent. of recoveries are even better, and as many as fifty of Casper's sixty-seven cases were cured. The most important points in the prognosis are the early recognition of the disease, and the application of proper treatment.

Treatment.

The internal treatment of renal tuberculosis consists of dietetic and symptomatic measures, which should only be employed as an aid to other treatment, or as a makeshift, if the latter is refused. Most important is a diet suited to the kidney; the cutting off of all seasoned, strongly spiced, irritating foods and all alcoholic drinks. If the bladder is affected, plenty of milk, alkaline

waters and burch tea may be given. In bacterial infection of the urine, urotropin, salol, potassium chlorate, and boric acid may be given, and the bladder may be washed out. Hemorrhage requires absolute rest, a diet as dry as possible, ice-packs, and the internal use of suprarenal preparations.

Surgical treatment consists of removal of diseased nodules, and of nephrectomy, if necessary, combined with ureterectomy; though tuberculosis of the ureters heals of itself after removal of the kidney, according to Barth slowly in one to two years. Direct indications for the operation are dangerous hemorrhage, and persistent, severe colic. It is necessary for extirpation of the kidney that the other organ should be sound, or of sufficient working capacity, a fact which must be carefully determined by cystoscopy and ureteral catheterization. Bilateral disease is not always an absolute contra-indication, since removal of a much diseased kidney has been followed by spontaneous improvement in the other slightly affected organ. For bilateral disease nephrotomy, with removal of the caseous nodules, or partial renal resection, may be considered. Palliative nephrotomy, followed later by a radical operation, has given good results in reduced patients.

According to Garré, one should forbid pregnancy in a nephrectomized patient; but numerous observations of French writers, lately reported on by Hartmann and Poisson, are in accord with the view of Israel that pregnancy has no unfavourable influence on the remaining kidney, as long as it is healthy.

Lately removal of the kidney in bilateral disease has been less favoured, on account of the marked results of tuberculin treatment; but the opinions of urologists and surgeons are still at variance. Tuberculin can, in early renal cases, bring about a complete cure, and in advanced cases continued improvement. Tuberculin treatment is indicated in bilateral disease, when operation is refused, and as an after-treatment of renal operations, to clear up disease of the bladder and genital organs. Kato, who has energetically supported tuberculin treatment of renal tuberculosis, reports the results of twelve cases, of which eleven were either cured or markedly improved; it may be also noted that tuberculin does not only act on the renal mischief, but also on the primary disease, and so may prevent an infection of the opposite kidney, or other spread of the tuberculosis. To sum up, in unilateral tuberculosis of the kidney the best treatment is removal of the diseased organ, followed by a systematic course of tuberculin, while in bilateral disease the latter may be employed without surgical measures.

Since radiotherapy, the favourable influence of which on other advanced, inoperable, tubercular, abdominal disease has already been mentioned, has in cases of bilateral renal disease repeatedly led to permanent improvement (Bircher), it should be combined with the specific treatment.

Rollier has recorded quite astounding results of treatment by sun rays, even in hopeless cases of tubercular disease of the urinary organs. He begins by exposing the lower extremities to the sun, and gradually uncovering more and more of the body, till the patient is entirely exposed to the insolation.

With all methods of treatment general hardening measures and all other hygienic factors are necessary.

7. TUBERCULOSIS OF THE SUPRARENAL BODY.

Anatomical Changes.

The disease begins with a formation of tubercles in the medulla. As the caseation advances the disease spreads to the cortex.

The organ increases considerably in size, so that its normal weight of 5 to 8 gm. may be increased to 300 gm. or more. It is then converted into an irregular, nodular tumour. On section between the caseous areas a greyish-red tissue, consisting of still normal gland tissue, may be recognized, or the whole tumour may consist of caseous masses. Usually both sides are affected. The disease may involve the coeliac ganglion, and solar plexus of the sympathetic.

Symptoms and Course.

Tuberculosis of the adrenals is the most frequent anatomical cause of Addison's disease, which is not a pathological entity,

but only the clinical representation of a definite symptom-complex. The symptoms develop gradually, and consist of weakness, pallor, digestive troubles, loss of appetite, vomiting, diarrhoea, wasting, characteristic pains in the loins, and progressive loss of memory and psychical depression. A cardinal symptom, which rarely fails and which clinches the diagnosis, is a peculiar pigmentation of the skin, which begins as a dirty grey coloration, and develops into a deep bronzing. The mucous membrane of the mouth and throat may present patches of the coloration, which is then usually blackish. The sclerotics, palms, soles and nails generally remain free.

The duration of this rare disease may be between several months and two or three years. Its course is progressive; a case at present under our treatment shows marked cyclical changes; periods of quite good general condition alternate with periods of giddiness, vomiting, marked weakness, and greatly increased

pigmentation of the skin. The patients generally die of exhaustion. Men in middle life are most often affected. In about half the cases pulmonary tuberculosis is found. In a case reported by Werner the condition was associated with tubercular disease of the urogenital apparatus, whence by means of the retroperitoneal lymphatics the disease had spread. Much about the disease is still obscure.

Diagnosis.

The recognition of Addison's disease as such is easy, so soon as the typical pigmentation of the skin is developed. It may, with probability, be ascribed to tuberculosis of the suprarenal glands, if tubercular disease of another organ can be detected.

Prognosis and

Treatment.

Tuberculosis of the adrenals is an incurable disease, and ends fatally. Treatment is useless, and purely symptomatic. We have seen no good results from tuberculin.

B. Tuberculosis of the Female Genital Organs.

Besides the special tubercular diseases, other affections of a non-specific nature may implicate the female genital organs during the course of chronic pulmonary tuberculosis, which have not only a symptomatic value, but also are important ætiologically. The extremely frequent disturbance of the menstrual function must be first mentioned. Sometimes the menstruation, especially at the commencement of the disease, is profuse, sometimes it is scanty, and nearly always painful. Often it is absent for many months; not uncommonly it is replaced by leucorrhœa. Many of these cases suffer from more or less severe anemia. Amenorrhœa and dysmenorrhœa are frequently met with in latent, as well as in manifest, tuberculosis, as a consequence of intoxication. They are often accompanied by rises of temperature, and may be suitably treated with tuberculin. Recognized types are pre-, inter- and post-menstrual fever. The connection between the temperature and menstruation is very complicated, and appears more so since attention has recently been paid to it. It depends on the problem of the secretion of the ovary, and its action on separate organs and the functions of the whole organism. It has a special diagnostic importance, but is of no value for prognosis.

Endometritis, limited to the cervix or extending into the body of the uterus, is of symptomatic importance. Amenorrhœa is not uncommonly due to atrophy of the uterus, affecting only the body of the uterus. Catarrhal salpingitis is more frequently

observed. Atrophy of the ovaries may also occur. A symptom of those conditions, which are often combined, is leucorrhœa, which leads secondarily to erosion of the cervix.

With or without atrophy of the uterus retroversions and retroflexions are often found, with relaxation of the ligaments, permitting prolapse of vagina and uterus, causing pains in the rectum and bladder. The changes are due both to the wasting of the patient and the consequent relaxation of the tissues, and in advanced pulmonary disease to venous congestion.

Just as chronic phthisis may cause functional alteration and even pathological changes in the genital organs, so the existence of disease of the sexual organs, or even the action of the genital function, may undoubtedly affect the course of pulmonary tuberculosis. A connection between menstruation and phthisis is seen in the fact that the catarrhal phenomena in the lung become more marked before and during the period, and often first appear then, a point of direct diagnostic value. It is not, however, justifiable to conclude that the menstrual function has an unfavourable influence on pulmonary tuberculosis. The not uncommon periodic hæmorrhages are worthy of notice; they either occur at the same time as a scanty menstruation, or replace it (the so-called vicarious menstruation).

Severe and frequent menstrual hæmorrhages on account of their weakening influence require careful treatment by rest, styptics, plugging, or curetting. The same treatment is required for metrorrhagia due to endometritis, submucous myoma, or tumour of the adnexa.

All acute and chronic inflammatory conditions of the sexual organs, all displacements causing pain or discomfort, and all simple new growths, are more or less serious complications, while malignant growths cause a rapid advance of the tubercular disease. Their unfavourable influence on pulmonary tuberculosis is due to a lowering of the general power of resistance, on account of insufficient nutrition, of rises of temperature, of direct injury to the heart and lungs from circulatory congestion, and not least, of the nervous, neurasthenic and psychical disturbances, which are rarely absent in cases with disease of the genital organs. They are of special importance in cases of phthisis, for in no other disease is the prudent, patient, and constant co-operation of the sufferer so important for cure.

All diseases of the genital organs also increase their susceptibility to the tubercle bacillus, and favour the development of a genital tuberculosis. This is especially true of gonorrhœa, which plays the same predisposing part for the sexual organs of women,

as was described in the section on Male Urogenital Tuberculosis. The remarks which were then made as to primary and secondary, and ascending and descending, forms of infection also hold good.

I. TUBERCULOSIS OF THE VAGINA.

Anatomical Changes.

Tuberculosis of the vagina presents itself in the form of miliary granules, superficial erosions, and deeper ulcerations with sharp jagged edges—different stages of the same process.

Symptoms and Course.

The clinical symptoms are slight, and may be absent. Increase of secretion first appears when the disease reaches a certain stage; and the cause of it is usually accidentally discovered. The disease is mostly secondary. Primary cases confirmed by autopsy are not known, though their occurrence is possible.

Diagnosis.

Characteristic tubercular nodules, or tubercle bacilli in the secretion, will make the diagnosis certain, and will distinguish tubercular from syphilitic ulceration. In doubtful cases a portion of the ulcer may be removed for microscopical examination, or inoculation on animals. Also the visible focal reaction to a diagnostic tuberculin injection may make the diagnosis certain.

Prognosis and Treatment.

The prospects of cure are good of themselves, but depend on the condition of the sexual organ which is primarily affected. Excision gives the most certain results. Small ulcers may be treated by cauterization and application of iodoform powder. A more important point is the treatment of the primary disease, on the success of which will depend the course taken by the vaginal affection. General hygienic treatment must be combined with tuberculin. Veit recommends the new tuberculin on the grounds of his own experience. To prevent spread of the infection sexual intercourse must be forbidden, and the bedding and clothing disinfected.

2. TUBERCULOSIS OF THE UTERUS.

Anatomical Changes.

Three varieties of uterine tuberculosis may be distinguished, the miliary, the interstitial, and the ulcerative forms. These are probably not essentially different, but depend merely on the stage of development. Tubercular endometritis begins with a deposit of miliary tubercles, especially at the fundus. As in all forms of mucous membrane tuberculosis by the breaking down of these

ulcers are formed, which may affect any parts of the uterine mucosa. In advanced cases the whole endometrium is destroyed; and the uterus is regularly enlarged, up to three times its normal size, from infiltration and hyperplasia of the muscular layers. In the uterine cornua nodular thickenings have been found. If the cervix becomes plugged, or obstructed by inflammatory swelling or retroflexion, the pent-up pus will produce pyometra. The thick secretion often contains caseous particles. Uteri have been found both in children and adults full of caseous masses.

Tuberculosis of the cervix leads sometimes to a peculiar infiltration of the vaginal portion with papillary outgrowths of the size of a walnut to an apple; by the partial necrosis of these cancer of the cervix may be simulated.

Symptoms and Course.

The clinical symptoms of early cases are slight and not to be distinguished from those produced by other forms of catarrhal inflammation. They consist of a mucoid or mucopurulent secretion, alteration of menstruation, and a mucosanguineous discharge, which may increase into irregular hæmorrhages. As the disease advances the uterus enlarges, without the appearance of typical symptoms. In the stage of pyometra the uterus is converted into a spherical, fluctuating swelling. Sometimes the discharge in advanced cases contains characteristic caseous particles.

Tuberculosis of the uterus is a fairly common disease. It may be primary, but it is rarely so. More often it is secondary to disease of the tube.

Diagnosis.

Since tuberculosis of the uterus causes no unmistakable clinical symptoms the diagnosis must depend on the discovery of tubercle bacilli in the discharge, which is very difficult in the early stages on account of scarcity of bacilli. If the suspicion of uterine tuberculosis has been raised by the presence of disease in another organ, it can be confirmed in an early stage by the microscopic examination of the endometrium removed by curettage. A tuberculin injection may also clear up the diagnosis by producing a local reaction in the form of uterine hæmorrhage and pains. The tuberculosis of the vaginal portion, which takes the form of a papillary tumour, must be diagnosed by excising a portion of tissue, if bacilli cannot be found in the discharge and animal experiments fail.

Prognosis.

The prognosis depends upon whether the uterus is the primary organ affected, whether the tubercular disease remains limited to the uterus, or if

not, what form the disease has taken in the other pelvic organs. In general it is good.

Treatment.

Considering the possibility of ascending tuberculosis of the sexual organs originating from the vagina, as shown by the experiments on animals of Bennecke, Jung, Bauereisen, and Menge, to which v. Franqué has lately drawn attention, more attention than hitherto should be paid to prophylaxis. In the first place sexual intercourse should be forbidden, not only with men suffering from urogenital tuberculosis, but with all phthisical cases. Also the possibility of transference of the tubercle bacilli from the patient herself or from another person, by means of sputum, infected instruments, washing, &c., is to be remembered. This is of particular importance during abortion, labour, or the puerperium.

So long as the disease is limited to the uterine mucosa a thorough curettage may lead to complete cure. Also when the disease has penetrated into the uterine wall scraping the ulcers may cause considerable improvement, by diminishing the purulent discharge and the bleeding. An after-treatment of washing out the uterus, plugging, &c., will be usually required.

If the vaginal portion is diseased in the manner described, amputation of the cervix will be necessary, provided the mischief is limited to that part. If the uterus only is affected extirpation will cause a complete cure, but the condition is rarely sufficiently severe to demand this. If the uterine disease is secondary to that in the tubes this must be considered in planning the operation. Uterine tuberculosis being an open disease too much care cannot be taken to prevent the spread of infection.

Careful general treatment is important. There are no reports of tuberculin treatment of isolated uterine tuberculosis.

3. TUBERCULOSIS OF THE TUBES.

Anatomical Changes.

According to Wehmer there are two different forms of disease; the acute caseous, and the chronic miliary or fibroid varieties.

The acute caseous form begins by a deposit of nodules in the mucosa, quickly destroying the mucous membrane, which with the thickened secretion forms a caseous pulp. The submucous and muscular layers are hypertrophied. In later stages the tubes are much twisted and dilated, and form stiff rolls, of the thickness of a finger. Their shape is very variable; they have been compared to a sausage, a club, a reed, a torpedo, or a rosary. The ampullary end of the tube is usually the most expanded. The os uteri abdominale is in half the cases obliterated, in the others

it remains open. Adhesions to the surrounding organs usually occur later. The chronic military variety is characterized by an early closure of the abdominal opening, which leads to the formation of a pyosalpinx. The destruction of the mucosa takes place more slowly. Numerous tubercular nodules form in the mucous membrane, but they have no tendency to rapid necrosis. The contents are at first a thin, serous fluid, which gradually becomes purulent and caseous. The necrotic masses are mixed with secretion and may induce a very characteristic hypertrophy of the wall of the tube. The chronic fibroid form is a variety of this in which there is only a very slight tendency to caseation, and the formation of fibrous tissue predominates over the deposit of tubercles.

As the disease advances it may involve neighbouring organs; military nodules and a membranous exudate appear on the serous coat of the tube, leading to matting together of the pelvic organs and intestines, to effusion into the peritoneal cavity, and later to extensive firm adhesions with the posterior surface of the broad ligament, the uterus, the pelvic wall, the bladder, the rectum, and the sigmoid. Gradually the pelvic organs are converted into an extensive, irregular mass. The extension of genital tuberculosis to the peritoneum, and their mutual connection, have already been described in the section on tuberculosis of the peritoneum.

Symptoms and Course.

The clinical symptoms vary according to the primary or secondary nature of the tubal tuberculosis, whether it is isolated or whether neighbouring organs are involved. In any case, they are not characteristic of tuberculosis, and furnish no sure ground for the recognition of the disease. The physical signs are of the greatest value. According to Hegar two different stages can be distinguished; either the individual pelvic organs are still separate on palpation, or they are so matted together by exudation that they can no longer be distinguished from each other. The different shapes of the swollen tubes depend on the anatomical changes. They seldom reach the size of a goose's egg, save in exceptional cases. The tubes may be considerably displaced; they may lie at the side of the uterus, or in the postero-lateral part of the pelvis, or even in the pouch of Douglas. According to Hegar it is characteristic of tuberculosis, in contrast to the usual forms of pyosalpinx, that the swelling occurs in the middle part of the tube, that it assumes a more irregular, polygonal shape, and that it is usually more solid, and may vary in consistency in different parts. Hegar also considers that a point of value is the

thickened, hard condition of the broad and utero-sacral ligaments, and on their surfaces small, nodular tubercular deposits may be felt. Occasionally tubercular deposits may be palpated on the posterior wall of the uterus and the anterior surface of the rectum, generally only on rectal examination, as Sellheim has especially remarked; but similar nodules of a non-tubercular nature may occur, especially in chronic inflammatory adenomyositis of the uterus. Exudation is rarely absent in advanced tubercular disease.

Tuberculosis of the tube forms the greatest percentage of all cases of genital tuberculosis; according to Summonds, Merletti, Targett, about 90 per cent. In most cases other parts of the genital tract are also affected, but the disease in the tube is usually the most advanced, and appears the oldest. As predisposing causes are the marked folding of the mucous membrane of the tube, the stagnation of secretion, the relative poor vascular supply, and lastly, the frequency of gonorrhoeal affections. Usually both tubes are affected at the same time. The infection in exceptional cases may ascend from the vagina, but the descending form is more common. Primary disease of the tube has undoubtedly been seen, but is rare; much more often it is a secondary disease, the infection being conveyed by blood-vessels or lymphatics from some other focus in the body, or spreading by continuity from the peritoneum, the bowel, or the urinary organs.

Diagnosis. Though the physical signs give no certain indication for the recognition of the disease,

frequently a probable diagnosis can be arrived at. The history of the patient, arrested development of the genital tract (Sellheim) detection of other organic tubercular disease, and prolonged observation may put it on a surer basis. The "abrasio mucosae" introduced by Sellheim as an aid to diagnosis in doubtful cases, and which has been further recommended by Krönig, since in about 50 per cent. of the cases it settled the diagnosis of tuberculosis of the adnexa, v. Franqué holds to be not permissible. He only allows it for small, hard, tubal thickenings, and, indeed, warns the practitioner entirely against this diagnostic measure. Effusions may be punctured through the vagina or the abdominal wall, and the discovery of tubercle bacilli or the result of animal inoculation will assist the diagnosis. There are cases, especially of the chronic variety of tuberculosis of the tube, which are not to be distinguished macroscopically from simple pro-salpinx; microscopical examination alone gives the correct diagnosis. There are very rare cases which microscopically appear to be purulent inflammation of the tube, and only in serial sections may tubercle bacilli be found.

The differential diagnosis must be made from gonorrhœal pyosalpinx, and malignant tumours. A diagnostic tuberculin injection gives very valuable information by producing a focal reaction (pain and a feeling of weight and pressure), and is very often decisive, though lately observations of the unreliability of tuberculin reactions have been made by v. Franqué, Schlämpert, and Zöpferitz. Only in rare cases will a diagnostic laparotomy or colpotomy be required.

Prognosis.

The prospects of healing of tuberculosis of the tube are not bad. Even when accompanied by pulmonary tuberculosis healing under general hygienic measures has been observed. The prognosis has become much more favourable since the introduction of tuberculin treatment. Even in advanced cases a complete cure may be obtained by operation. The prognosis depends on the general condition of the patient, and on the stage of the disease of the other organs, especially of the lung, which usually accompanies tuberculosis of the tube. The occurrence of general miliary tuberculosis is rare.

Treatment.

The prophylaxis is the same as for uterine tuberculosis.

On the expediency or necessity of surgical interference the views are divergent. Practical experience, and the realization that the tuberculosis of the tube is much more rarely primary than was previously thought, have led to a diminution of the scope of the operation. But there are renowned gynaecologists, such as Kröning, Bunin, Schaula, who are still complete adherents of operative treatment. Veit, who takes a more conservative standpoint, warns against all operative measures during the acute febrile stage. On the other hand, v. Franqué is a strong supporter of surgical measures for disease of the adnexa, and recommends operation when this is the only clinical tubercular localization, or if it is the most prominent, provided that it is not already in an old, quiescent condition. The advantages of a timely operation, which those experienced in the pathological anatomy of genital tuberculosis, such as B. Simmonds, also recommend, are, according to v. Franqué, that the patient is at once relieved from all symptoms and threatening dangers, and that the cure will last for years, or be permanent; while conservative treatment, on account of the slight tendency to spontaneous healing, will in the best cases take a very long time, and in cases under unfavourable social conditions will not give the requisite impetus towards healing. In favour of operative treatment have also been raised the arguments that there is a constant danger of the superinfection of mixed infection from the bowel, that extra-uterine

gestation has frequently been observed with tuberculosis of the tube, that chronic tuberculosis predisposes to the development of carcinoma, that there is a possibility of the spread of the disease to the surrounding organs, or to the lower part of the genital tract, and that if the uterine mucosa thus becomes affected the tuberculosis will become open, and be a constant danger to the patient herself and to those in contact with her. At the German Congress of Gynecology, held in Munich in 1911, the majority, including Zweifel, Kustner, Fehling, Menge, Sioerckel, Sarvey, Gottschalk, Opitz, Wertheim, Stratz, &c., supported a more or less operative treatment. A more moderate and selective standpoint, taken by van Herff, Sellheim, and Sappel, is that the operation is indicated when in spite of conservative treatment there is no tendency towards arrest of the disease, and when complications in other organs do not make the prognosis after operation doubtful. Special indications are severe pains, marked loss of strength, rapidly progressive disease, constant relapses on account of mixed infection, large collections of pus, continued fever, and threatened or actual perforation of the bowel. The operation consists of partial or total resection of the adnexa; on one or both sides; or of the radical operation (panhysterectomy) if the disease is more severe and extensive. On account of the better view obtained of the disease, the previous diagnosis being always incomplete, laparotomy is to be preferred to colpotomy. It is contra-indicated if there is advanced tuberculosis of the lungs or other organs, and if the genital tuberculosis is very extensive, and accompanied by dense adhesions. In these cases puncture of effusions, opening, and draining abscesses, and if there is secondary tubercular peritonitis, simple laparotomy, may be required.

Recently in cases of genital and plastic peritoneal tuberculosis too far advanced for operation, marked improvement, and even cure, have been obtained by radiotherapy, as Bircher, Gauss, Spoeth, and others have remarked.

Lastly general hygienic treatment, removal from the domestic sphere, complete rest to the sexual organs, and, if possible, treatment in a sanatorium, especially if the lungs are also affected, may give good results. The pains in the pelvis will require symptomatic treatment.

The conservative treatment is more hopeful the sooner it is combined with tuberculin; it may bring about complete healing in disease of the adnexa as in tubercular peritonitis, a fact specially noted by Birnbaum, Prochownik, and Busse. Also Veit forcibly recommends the new tuberculin, with which he has seen better results in genital tuberculosis than with operation.

4. TUBERCULOSIS OF THE OVARIES.

**Anatomical
Changes.**

Pfannenstiel and Orthmann distinguish tubercular peri-ovophoritis and true ovarian tuberculosis. The former is part of tubercular peritonitis; disseminated tubercular granulations, or a plastic exudation containing nodules, forming on the surface of the ovary, which itself is not diseased. These authors again divide the true ovarian tuberculosis into military and caseo-suppurative forms, which may be combined. The rarer military form can hardly be recognized at times by the naked eye. Particularly in cases of tubercular peri-ovophoritis one finds in the ovary numerous very small tubercles. Bacilli are often very difficult to detect. The caseous variety with abscess formation is more common, and is usually situated in the stroma of the ovary, more rarely in a corpus luteum; it may be single or multiple. The caseous nodules may join together, suppurate, and form a cavity of the size of a goose's egg.

**Symptoms and
Course.**

Tuberculosis of the ovary is a fairly frequent disease. In about half the cases it is bilateral. In 267 cases of genital tuberculosis collected by Kroeber the ovary was affected forty-two times; Orthmann estimates that it is diseased in as much as 42 per cent. of the cases. Sometimes the infection occurs through the blood; cases are described in which the ovary was alone diseased, and the rest of the genital organs healthy. As a rule the infection spreads from the tube by means of peritoneal tuberculosis. Fibrinous encapsulation or complete atrophy of the ovary sometimes prevents infection. The further fate of secondary ovarian tuberculosis depends on the course taken by the tuberculosis of the tube.

Diagnosis.

The rare cases of isolated ovarian tuberculosis can hardly be diagnosed as such. The recognition of ovarian disease secondary to that in the tubes may be made by palpation, but it is without importance, as it hardly influences the prognosis or treatment.

**Prognosis and
Treatment.**

These both depend entirely upon that of the tuberculosis of the tube.

5. TUBERCULOSIS OF THE BREAST.

**Anatomical
Changes.**

Apart from the rare form of military tuberculosis of the breast occurring as part of general military tuberculosis, three different forms have been described: the disseminated, the confluent, and

the cold abscess. In the disseminated form a few small nodules of the size of a hazel-nut are scattered through the tissue of the breast, being completely isolated and surrounded by healthy gland substance. The confluent form, which is most often situated in the upper and outer quadrant of the breast, develops in the form of one or more infiltrating nodules, which grow very slowly, and may involve the whole mamma. The disease begins by a deposit of small, usually confluent, nodules in the interacinous tissue, the glandular tissue being only secondarily affected. The nodule softens and breaks through at one or more places, and discharges characteristic, soft, granular or crumbling masses. If several nodules co-exist, in the process of necrosis communications and fistulae will be formed between the cavities. Quite early the axillary glands become swollen, and usually suppurate. The cold abscess is produced by a still slower process. It develops in the intermammary tissue, and is separated by a fibrous capsule from the healthy gland substance.

Symptoms and Causes.

In the rare disseminated form isolated, small nodules can be felt, without the gland being much enlarged. The overlying skin is nearly always unaffected. The disease lasts for years, and may result in spontaneous healing, in calcification, or in abscess formation. The most common confluent form of mammary tuberculosis in the early stages sometimes only causes slight symptoms, so that the nodules are usually accidentally discovered when they reach a certain size. More often inflammatory irritation shows itself by pains or swelling of axillary glands. The nipple is frequently drawn in; the breast itself is nearly always freely movable. Softening is recognized by fluctuation; unless opened, pus will gradually discharge spontaneously. A cold abscess develops extremely slowly without any local inflammatory signs, and usually without alteration of the axillary glands. A fluctuating, circumscribed tumour can be felt.

Mammary tuberculosis is relatively rare; generally it is a complication of pulmonary tuberculosis; the estimates of its frequency vary. At first it is exclusively unilateral. It occurs chiefly during the years of sexual activity. Infection through the blood, apart from miliary tuberculosis, is very rare. Extension of tuberculosis from the axillary glands, the ribs, and the pœura has been observed in a few cases. According to Cornet the infection most frequently occurs from outside, rarely by the entry of bacilli into the ducts of the glands, more often the bacilli enter by an excoriation, and are conveyed by the lymphatics which accompany the galactic ducts. This agrees with the interacinous develop-

ment of the early stages. Traumatism and inflammations favour the occurrence of the disease.

Diagnosis.

The recognition is easy if tubercle bacilli can be found in the secretion or in drawn-off pus. Tubercular disease in other organs may point to the cause of a prolonged, suspicious, inflammatory process in the breast. Retro-mammary abscesses usually develop more slowly and cause more pain, fever and swelling; and palpation shows that the abscess is not within, but behind, the breast. The closed form of mammary tuberculosis may be most easily mistaken for an early carcinoma. In favour of the latter will be the hardness, the shape and the painlessness of the tumour, the drawing in of the nipple, the adhesion to the overlying skin or fascia, and the carcinomatous glands in the clavicular region. A syphilitic gumma may be recognized by its rapid development and quick necrosis; other signs of syphilis are seldom absent; and it reacts promptly to anti-syphilitic measures. Adenoma, fibroma, and a cyst are more easy to distinguish; they are usually circumscribed, movable, painless, and do not suppurate. There may be great difficulty in diagnosis if tuberculosis is combined with cancer, adenoma or fibroma.

Prognosis.

When the disease is limited to the breast, or when the affected lymphatic glands do not yet form an extensive mass, the prognosis is good.

Treatment.

The best results are given by amputation of the breast. Partial excision, scraping, &c., do not take the place of a radical operation, and do not prevent relapses, since the disease is always more advanced than seems to the naked eye. Amputation of the breast is to be the more recommended, as the chronic inflammatory condition offers a favourable ground of development to cancer.

8. TUBERCULOSIS IN CONNECTION WITH MARRIAGE, PREGNANCY, THE PUERPERIUM, AND ABORTION.

The consideration of genital tuberculosis, and the connection between tuberculosis and the genital organs must be completed by a review of the relationship between the disease and the sexual functions and their consequences. The periods of development and of sexual maturity are exactly the ages most favoured by tuberculosis.

The alterations of menstruation during the course of chronic pulmonary tuberculosis have already been mentioned. Ovulation may be arrested as a consequence of the general bodily weakness. A permanent sterility may be produced by atrophy

of the ovary and the uterus, also by advanced tuberculosis of the genital organs. Conception is rendered more difficult or even prevented by most of the non-tubercular affections of the genital organs that have been mentioned; but pulmonary tuberculosis of itself is no prevention of conception except in its terminal stages.

There is now a consensus of opinion that pregnancy frequently makes manifest a latent tuberculosis, and aggravates an already existing disease. This is not only true for phthisis, but also for surgical tuberculosis and lupus, while urogenital tuberculosis usually remains uninfluenced. Besides the social conditions, the grade and form of the disease are naturally of importance; early cases, closed cases, torpid, fibrous forms tending to encapsulation and contraction pass through pregnancy much better than severe, dangerous, open, diffuse, ulcerating, cavity-forming and advanced cases. But even in cases of the first category it happens often enough that after a good progress at first, with stationary physical signs, an acute exacerbation occurs, and that a single pregnancy irresistibly annihilates the best results of a prolonged sanatorium treatment. It is of practical importance that such a relapse may happen without warning during the second half of pregnancy, without the occurrence of fever or loss of weight or other bad symptom, an evidence of the difficulty of giving an accurate prognosis in individual cases. A satisfactory explanation of the evil effects of pregnancy on tuberculosis has not yet been found, they have generally been ascribed to the changes in the type of respiration and the blood supply of the lungs which take place during the latter months. According to Hofbauer's researches causes of the increased predisposition are reduction of the lipolytic faculty of the serum with advancing pregnancy, hyperglycemia, and certain physical causes, such as hyperaemia, increased lymphatic flow and peribronchial infiltration.

Still more injurious in its effects on tuberculosis than pregnancy is the puerperium.

This leads us first of all to the important question of prophylaxis. The dangers of the marriage of tubercular persons cannot be too forcibly impressed. The danger of infection between married people has certainly been much underestimated, even by doctors. This is partly because statistics on this point have been drawn chiefly from the upper ten thousand; and the confined social conditions of the poorer classes have been too little considered. These statistics also err in that they are founded too much on the statements of the patients themselves, and that they do not sufficiently consider whether the tuberculosis

is open, and how long it has been so, and whether the patient was living with the husband during the time of the possibility of infection. The unreliability of these figures is increased by the fact that the health of the presumably unaffected husband is but very rarely confirmed by a medical examination, and that nothing is known as to his later history. The figures of Weinberg, collected from reliable mortality statistics, seem to us to be of more value; according to these the mortality of those married to a tubercular person was twice as great as the average.

Marriage may have a beneficial influence on a tubercular man, since his material conditions may be improved, and especially his food and general mode of life may become better and more regular. For him, too, sexual relationships may only be changed for the better, quite apart from the elimination of venereal infection.

Things are very different for the woman patient. For her, too, indeed, the social conditions may be improved, if she has hitherto supported herself by her own work. But the conditions of cure become more unfavourable if the circle of her duties is enlarged. The commencement of sexual life cannot be considered to be entirely without influence. Consideration must be paid also to the possibility of the spread of the disease to a healthy part, to the dangers of pregnancy and childbirth for the tubercular woman, to the possibility of transmitting the predisposition, and especially to the danger of infection of the child after birth, who generally has but small powers of resistance; the duty of the doctor, therefore, is to be most cautious in giving permission for marriage. The demand for a legal restraint of marriage seems to be still impracticable. More important and more practical is to aim at a general enlightenment on these questions, and to give warning and advice in individual cases.

With regard to the infection of the female genital organs it may once more be mentioned that in the semen of phthisical patients, who are free from disease of the genital organs, tubercle bacilli have been found, that phthisical patients who have also tuberculosis of the genital organs long remain capable of conception, that guinea-pigs with tuberculosis of the genital organs produce the same disease on the female, and that lastly there is danger for the woman of an ascending genital tuberculosis by contact infection from an infected husband. These facts justify prohibitive measures.

With existing tuberculosis of the wife pregnancy is to be prevented till the disease is completely healed. Only when the lungs have given no clinical symptoms for two or three years may

pregnancy be permitted by the doctor, and the lungs must then be carefully watched. There are various means of preventing pregnancy which may be employed. Lastly facultative sterilization by dividing the tubes, or complete sterilization, may have to be considered. Lately Krönig and others have succeeded with sufficient doses of Röntgen-rays in obtaining sterilization with preservation of menstruation. Time will show whether ovulation can return, so that after a certain time conception may again be possible.

If pregnancy occurs with manifest, active tuberculosis artificial abortion is indicated. The bad effects on the disease will not be thereby always prevented, but the trial must be made. In early or inactive cases of tuberculosis the doctor may wait; if the objective signs or the general symptoms become worse, abortion must be then induced. The result of the tuberculin reaction cannot be used as an indication for this (Veit, F. Kraus, Kammerer); still less can one be guided by the conjunctival reaction, as recommended by E. Martin, who takes a positive reaction as showing strong powers of resistance, while he considers a negative result to indicate the induction of abortion. The capacity of resistance falls, or is extinguished, at the end of pregnancy, to be increased again during the puerperium. Stern is inclined to explain the negative results of cutaneous and conjunctival tests by a loss of antibodies accompanying pregnancy, on account of the saturation of the immune corpuscles with the serum rich in lipoids (Heynemann). In any case the explanation of the state of the tuberculin reaction during pregnancy is still very complicated, and the value of the reaction for diagnosis and prognosis is more doubtful than in the non-pregnant, so that a negative result is not always to be considered as an unfavourable sign. The experience that the induction of abortion does not prevent the aggravation of phthisis in all cases, and that in favourably situated, early cases pregnancy may be passed through satisfactorily, is against the radical view of Maragliano and Hamburger that abortion should be induced in all tubercular patients. With regard to the spontaneous interruption of pregnancy in tuberculosis there are differences of opinion; abortion seems to occur rarely; premature birth is commoner, and the more so the more advanced is the tuberculosis.

Artificial induction of premature labour has no advantage whatever over normal confinement; many gynaecologists even think that it is more dangerous; we can support this view as the result of several experiences. Pankow and Kuglerke have lately deduced from the large, uniform, and continuous statistics of the

Freiburg Women's Clinic that the results are relatively good if the induction is performed early; but the high mortality of 40 per cent. of even the cases in Stage I indicates the gravity of the prognosis, when the disease becomes active in the second half of pregnancy. Pankow and Kupferle draw the same conclusion as Krönig that one should not wait too long, and allow the most favourable time for interrupting pregnancy to pass. After the fifth month induction of labour must as a rule be avoided, except that it may be considered in the interests of the child in extreme cases, or in patients who are rapidly going downhill on account of advancing disease or complications. In such cases with advanced pregnancy Henkel considers that the best and surest way of relieving the patient is total abdominal extirpation of the gravid uterus under lumbar anaesthesia. The operation involves the least risk for the patient and the smallest possible loss of blood, a factor of extreme importance; the elimination of the puerperium also has a very important curative effect.

Since the interruption of pregnancy often enough does not stop the aggravation of tuberculosis it has recently been authoritatively recommended that the patient should be sterilized at the same time. It is not yet agreed whether a facultative sterilization, an extirpation of the uterus with or without the adnexa, or excision of the fundus (*v.* Bardesleben) is necessary. The supporters of total extirpation take the ground that the internal secretion of the ovary has a bad effect on tuberculosis, and that castrated individuals often gain in weight marvellously. We cannot, however, refrain from observing that this gain in weight is chiefly due to a deposit of fat, and that this has not the importance for the cure of tuberculosis that was formerly supposed, and that adiposity by itself even makes the prognosis of tuberculosis worse (*p.* 166). The question does not seem to us to be yet ripe for judgment, and a knowledge of the after results is much needed.

The dangers of labour consist of circulatory congestion and of dyspnoea, which may lead to oedema of the lungs. Difficult labour and much bleeding may lead to the disease rapidly becoming worse, as often happens during the puerperium, even when pregnancy has been well borne. Miliary tuberculosis is not rarely met with during pregnancy and the puerperium.

With regard to the desirability of suckling by the tubercular mother there is still a difference of opinion. The danger of transference of tubercle bacilli to the infant from the mother's milk is a very real one; according to observations on animals and humans the mammary glands have no special defensive power, and Cornet was able in several rare cases to find tubercle bacilli in the milk of

tubercular women, who were not suffering from milary tuberculosis. Recent observations have shown that bacilli occur in the blood of phthisical patients much more frequently than was previously thought; however, the number of bacilli is very small in early cases, for whom alone the question of allowing suckling need be considered. The danger of infection from the mother's milk is very small compared with the much greater one of infection during the naturally intimate relationship between mother and child, provided that the tuberculosis is of the open form. Zeppert in particular has recently shown that the frequent occurrence of tubercular meningitis in the early years of life has no connection at all with breast feeding.

What influence then has suckling on the maternal tuberculosis, and how does it affect the child?

There are no exceptions to the rule that a mother suffering from advanced tuberculosis must be forbidden to nurse her child; and in all cases of maternal tuberculosis a wet nurse and separate rooms for the mother and child are to be recommended, where the material conditions allow.

There are divergent views as to the right line to be taken in the large number of cases of open tuberculosis in the mother, whose general condition is good, and who is compelled to live in more or less close contact with the infant. The way in which infection takes place is here immaterial. The modern treatises on tuberculosis by Czerny and Keller are in agreement with the older authors in considering maternal tuberculosis as a contra-indication to suckling. Schlossmann takes the opposite view that the mother should nurse the child, who is usually poorly developed and of feeble resisting power, so as not to increase by artificial feeding the inevitable danger of infection. According to him the child at the breast can better withstand a tubercular infection, which would be certainly fatal to an artificially fed infant. Suckling is often directly advantageous to the mother by stimulating nutrition changes, and by usually preventing a fresh pregnancy.

Considering the divergency of these views the recently published results of the exact observation made by Deutsch on nursing and non-nursing tubercular mothers and their offspring have the greatest importance. Besides healthy mothers used as a comparison he considered active, inactive, and suspicious cases of tuberculosis; the active cases had disease of the apex or upper lobe with favourable prognosis. Of the results of his examination the following are the most important:—

- (1) Suckling had on the tubercular mother only very rarely a

good effect, usually an unfavourable, and sometimes a destructive one.

(2) Almost all the infected children had been suckled by tubercular mothers, while the children who were not suckled, even if there was an hereditary tendency, all remained healthy.

The latter conclusion is surprising, and an explanation is difficult to give. If we do not suppose that the suckling mother, through her intimate contact with her offspring, increases the risks of the infection of the child, a view rejected by Deutsch and Schlossmann, we are driven to the conclusion that the milk of a tubercular mother contains a toxic substance, which in some way lowers the resistance of the child. Deutsch inclines towards this view, and at all events thinks that the opinion that the mother's milk increases the resistance of the infant has been shaken.

These conclusions show that the old teaching of universally forbidding suckling by tubercular women in the interests both of mother and child still holds good. The problem of infant mortality as a whole is so closely bound up with feeding by the mother, that the views advanced by Schlossmann in the case of tubercular women needed the proof of their correctness, which has been supplied by these extensive researches of Deutsch.

If the tubercular disease in the mother is arrested then suckling may be allowed as long as both mother and child maintain their strength and good general condition; but both need continued medical observation. A good condition and sufficiency of the milk are naturally necessary for the permission of suckling. An express warning must be issued against too long lactation, which weakens even a healthy person, and will aggravate an existing tuberculosis, or bring out a latent one. The warning is the more needed, as most women incorrectly believe that suckling is a certain preventative of another conception.

The most dangerous complication of a pregnant, tubercular woman is laryngeal tuberculosis, which frequently appears, even when the lung disease is only causing quite few symptoms. Laryngeal tuberculosis during pregnancy has a marked tendency to rapid spread; the disease very rarely remains stationary or improves. Swelling of the connective tissue with slight oedema, and increased shedding and leucocytic infiltration of the epithelium have been observed. The possibility of sudden death from suffocation must be remembered, particularly during labour. A much higher percentage of patients die suddenly after labour than the reported cases indicate. Most of the children, which are poorly developed, die either at once or in the course of a few weeks. The local treatment of the larynx is almost hopeless, as is also curative

tracheostomy. If stenotic symptoms suddenly develop the operation may prevent suffocation; the scanty reports are here also at variance.

Only when the general condition is good and the laryngeal condition slight can the pregnancy be allowed to continue. If the laryngeal disease is becoming worse the pregnancy must be terminated as soon as possible. With healed laryngeal tuberculosis pregnancy causes a danger of relapse.

CHAPTER VII.

Tuberculosis of the Vascular and Lymphatic Systems.

1. TUBERCULOSIS AND THE BLOOD.

Blood Changes.

Since the blood plays the chief part in resisting any infection, if it becomes altered by disease the organism will be more or less predisposed to tuberculosis. In fact the tubercular infection particularly attacks persons thus weakened, as may be seen in chlorotic and anæmic female patients.

On the other hand, during the course of tuberculosis the blood becomes affected by the specific toxins and products of tissue destruction, and undergoes alterations which can be recognized.

According to Grawitz the blood is affected in the following way in the different stages of tuberculosis:—

Stage I.—Erythrocytes diminished, leucocytes unaltered, hæmoglobin slightly reduced.

Stage II.—Without fever; erythrocytes unaltered, leucocytes moderately increased, hæmoglobin unchanged.

Stage III.—With fever; erythrocytes much diminished, leucocytes much increased, hæmoglobin reduced.

It is to be noticed that in Stage I with women there is not rarely a reduction of hæmoglobin, the number of red corpuscles remaining normal, and therefore the blood is the same as that of chlorosis. In Stage II there is sometimes a diminution of the total amount of blood—oligæmia—with a pale, dry, rough skin, and desiccation of the tissues. In the third hectic stage the leucocytosis increases with the duration of the fever and the advance of mixed infection, reaches its maximum in the so-called caseous pneumonia, and diminishes in the milary form.

However, Arnet considers the simple blood count to be insufficient and deceptive. According to him the characteristic

alterations in the blood of tubercular persons consist of a change in the neutrophile cells, the number of red corpuscles remaining normal and the number of white cells approximately so. Compared with normal blood, in which the leucocytes are 25 per cent. mononuclear and 75 per cent. multinuclear, the mononuclear cells are increased and the polynuclear neutrophile leucocytes diminished. This depends on the fact that the polynuclear cells are the chief carriers of antibodies and so perish in the fight against the infection, setting free their antibodies, which loss produces first a new formation of mononuclear cells, the latter being the youngest form. The majority of the workers on this subject on the whole agree with Arneth, but do not consider that this alteration of the neutrophile cells is a constant occurrence in tuberculosis.

The discovery of tubercle bacilli in the blood was first made by Weichselbaum in the blood of three corpses dying from acute miliary tuberculosis. Meissel, Lustig, and Rintameyer confirmed this for acute miliary tuberculosis during life. In chronic tuberculosis the discovery of bacilli in the blood was first made by Jousset, Lüdke, and especially G. Liebermeister as the result of numerous and careful observations, which showed that bacilli were very frequently to be found in the circulating blood of phthisical patients. Their detection is the easier, the more advanced and the nearer to the termination is the disease. Liebermeister obtained positive results during the last twenty days of life in 75 per cent. of the cases, and in only 25 per cent. examined eighty days before death; lately the results in open tuberculosis have been even more definite. Schnitzer found 32 per cent., Lippmann 44 per cent., Rosenberger in forty-nine cases, including five of miliary tuberculosis 100 per cent., and Kurashige in 135 cases of tubercular lung disease of all stages (thirty-five in the first, sixty-five in the second, and fifty-five in the third stage), also 100 per cent. of positive results. It was also discovered that it is not rare to find bacilli in the blood of even clinically slight cases. Jessen, L. Rabinowitsch, and lately Sturm have found, in 40 to 50 per cent. of cases still in the early stage, bacilli in the blood as a result of bacteriological and animal observations. The results are of importance for the explanation of many tubercular localizations, such as in the eye, the bones, and the joints, which previously were not clear; also for understanding the connection between tuberculosis and traumatism; and above all, for the proper recognition of pulmonary tuberculosis as a general disease.

The serological properties of tubercular blood, phagocytosis, complement fixation of antibodies, agglutinins, precipitins,

opsonins, anaphylactic reaction substances, &c., need not be considered here, since at present they are either doubtful, or of no practical importance.

Diagnosis.

In cases of diagnostic doubt, in which an abnormal condition of the blood is suspected, more information can generally be obtained from a stained blood preparation than from the more tedious blood counts.

We recommend the following method of obtaining a stained preparation of the blood. From the pricked finger the blood is allowed to flow spontaneously, *i.e.*, without pressure. A small drop is received in a coverslip, which has been passed three times through the flame, and covered with a second slip for half to one minute, the two slips being then rapidly drawn apart. The preparation having been dried in the air, it is stained for two minutes by the Jenner-May method, *i.e.*, with a 25 per cent. methyl-alcohol solution of eosin methylene blue, which fixes the film at the same time. The slip is then placed in distilled water for one minute; then dried with blotting-paper and mounted in Canada balsam. (Jenner-May's solution can be obtained ready-made, or it can be prepared as required from tablets; one tablet is to be finely crushed in 100 gr. chemically pure, acetone-free methyl-alcohol in a dry flask and dissolved by shaking; the solution is then filtered through a dry filter and placed in a carefully stoppered vessel.)

With this method the following structures can be clearly distinguished—

- (i) The erythrocytes are red, and the nuclei of the nucleated red cells stained blue.
- (ii) The leucocytes may be divided into—
 - (a) The mononuclear forms, with large, round, pale-blue nuclei and scanty protoplasm.
 - (b) The polynuclear forms with the nuclei always blue, but the protoplasm containing—
 - (i) In the neutrophilic cells rose-red or light-red granules (60 per cent.).
 - (ii) In the eosinophilic cells deep red granules (3 per cent.).
 - (iii) In the basophilic cells intense blue granules (10.5 per cent.).

The discovery of tubercle bacilli in the circulating blood has great practical importance. It settles all doubt in uncertain cases, in which fever, night-sweats, and nerve changes raise a suspicion of tuberculosis, but contra-indicate test tuberculin injections.

We recommend Kurashige's modification of the Schmitter-Staubli's method, which has the advantage of only requiring 1 c.c. of blood.

Blood to the extent of 1 c.c. is withdrawn from the median vein and added to 2 c.c. of 2 per cent. glacial acetic acid solution; after slight shaking the mixture is allowed to stand half to one hour. After centrifugation (at 5000 revolutions for thirty minutes) 1 c.c. of distilled ammonia are added to the sediment, which becomes clear either at once or after several minutes of vigorous shaking. The solution is again centrifugated till a little snow-white sediment comes down. This is so slight that the bottom of the glass appears only a little defiled. It is washed with

distilled water, and a preparation made and stained by Ziehl-Neelsen's method. If the sediment does not adhere well to the cover-slip it may be fixed with egg albumen water. The staining must be as short as possible, and the washing very carefully done.

Prognosis and Treatment.

The changes in the blood described by Arnetz do not indicate a bad prognosis. If the primary tubercular disease is still capable of treatment the administration of iron, or iron and arsenia (arsenoferrate), or the natural waters of Dürkheim, Pyrmont, Lecco, Ronciglione, may improve the condition of the blood.

The presence of bacilli in the blood-stream does not generally indicate military tuberculosis; and has not such a sinister significance as has been generally supposed. All the same it is not a good sign, and demands a cautious and reserved prognosis. There is no way of eliminating the bacilli from the blood.

2. TUBERCULOSIS AND THE CIRCULATION.

Anatomical Changes and Symptoms.

The vessels present in chronic cases of tuberculosis a thickening of the wall, probably as a result of the action of the toxins. Also arteriosclerosis and calcification of the inner elastic lamina have been observed in young phthisical patients; Postenger found premature rigidity of the arteries frequently. The results of the changes in the vessel wall are alterations in the blood flow, congestion and thrombosis, the last especially in the veins, where it is not rare in cases of tuberculosis. According to the researches of Liebermeister we may consider that there is a direct connection between the bacillæmia and the thrombosis. It may now be considered as certain that it is not hyperæmia but sluggishness of the circulation which gives the chief impetus towards the occurrence and spread of tubercular disease; with acceleration of the circulation the area supplied remains strikingly free from tuberculosis, while slowing of the blood-stream has the opposite effect; it favours capillary thrombosis, which is a predisposing cause of tuberculosis.

Bacilli in the circulating blood may become adherent to the vessel wall, penetrate the intima, and set up tubercles in the wall of the vessel, which appear as white prominences of the size of a pin's head to a hemp seed. Of the vessel may become involved from outside by contiguous disease, the bacilli growing by continuity through the vessel wall inwards to the intima. Both varieties of vascular tubercles may occur in veins and arteries; it is not easy to say which is the commonest.

Vascular tuberculosis may either appear as drop-like outgrowths (*endangitis tuberculosa*), or as infiltration followed by ulceration (tubercular ulcers of the vessels).

The aorta is most likely to be affected from tubercular mediastinal and bronchial glands. If it is already arteriosclerotic, large numbers of bacilli will be found in the upper layers of the atheromatous ulcers. Such an *endoarthritis tuberculosa* arises from the deposition of bacilli on roughened spots of the intima, where they multiply freely, and by becoming mixed with the bloodstream may set up miliary tuberculosis.

There is a large literature on the connection between tuberculosis and the heart. We may here limit ourselves to the most important facts. Firstly, there is the old view, supported by Brehmer and Bereske, and lately confirmed by Orth, that a proportion of tubercular patients, especially those of an asthmatical nature, have a heart below the normal size. Orthodiagraphic examination of the patients at the Heidehaus Sanatorium showed that of normally nourished cases 62.5 per cent., and of badly nourished 88 per cent., had too small a heart, and this was true not only with advanced phthisis, but also with early slight disease. The heart also undergoes during tuberculosis a cachectic diminution in size, analogous to the general wasting. The view that the smallness of the heart is one of the predisposing factors towards tuberculosis, is probably more correct than the theory that the reduced size of the heart is merely a consequence of an already existing tubercular infection. Alterations in the right side of the heart are usually due to complications of pulmonary tuberculosis, such as pleural adhesions, chronic bronchitis and emphysema; but in some cases hypertrophy of the right side may occur as a consequence of diminution of the circulatory area, brought about by indurative and ulcerative disease.

Displacements of the heart due to pressure or traction may affect its functions. If this is shown merely by heart failure and pains in the cardiac region, it may not be possible to say if they are due to the mechanical displacement or to toxic action. The most important and frequent functional symptom, acceleration of the heart's action or tachycardia, usually occurs as a consequence of toxæmia, it may be independent of fever and runs a parallel course with the severity of the disease. The abnormality of the regulating apparatus is also shown by variability of the pulse. Other signs of functional alteration of the heart which may be mentioned are want of clearness of the first mitral sound, a systolic apical murmur and fall in the blood-pressure, especially in advanced disease.

The teaching of Roitzansky that heart failure protects from pulmonary tuberculosis is not correct in this absolute form. It can only be said that mitral stenosis is accompanied by a diminished predisposition to tuberculosis, as is also mitral insufficiency, when in consequence of congestion it produces brown induration of the lung. The progress of an already existing tuberculosis will not be checked by heart failure; while tuberculosis, especially if rapid, unfavourably affects the compensation of valvular disease. The statement that hypertrophy of the left ventricle is a preventative of tuberculosis is also too general; if tuberculosis is rare in cases of aortic disease and arteriosclerosis, it is due to the fact that these conditions chiefly occur in later life, in which tuberculosis more seldom appears.

Diagnosis and Treatment.

The juvenile form of arterial rigidity may best be seen in the temporal arteries; though its clinical importance is not yet fully determined. We consider the symptom to be quite unreliable. Therapeutically the connection between tuberculosis and the circulatory organs must be remembered in relation to hydrotherapy, the specific treatment and Bier's congestion hyperæmia.

The diagnosis of tubercle of the vessels is rarely possible, since the detection of tubercle bacilli in the circulating blood in no way indicates that the vessel wall is affected. Treatment is hopeless, since ulcerating tubercle of the vessel wall usually causes acute miliary tuberculosis. Tuberculosis of the aorta also either cannot be diagnosed during life, or is incapable of being influenced by treatment.

The small size of the phthisical heart can be recognized by orthodiagraphic use of the Röntgen rays; if the measurements in two dimensions are considerably less than the average in people of the same size and weight, then it can be considered that the heart is too small. All the same, the size of the heart is a variable factor, depending on the sex, the age, the shape of the chest, and the state of the muscles; so that the diagnosis of reduction in the size of the heart is uncertain. The small heart, which is a congenital abnormality or occurs during development as a constitutional abnormality, cannot be influenced by treatment. At the most systematic exercises in young persons may increase the working capacity of the small heart.

Hypertrophy of the right ventricle can be recognized by a constant accentuation of the second pulmonary sound. If percussion shows a broadening of the absolute cardiac dulness to the right it must be considered whether it may not simply be due to an uncovering of a heart of normal size, such as frequently

occurs in consequence of retraction of the lung from cicatricial disease of the right apex. The treatment must be directed against existing complications in the lungs, so as to relieve as far as possible the obstruction to the pulmonary circulation.

Functional alterations of a mechanical or toxic nature are accompanied by abnormal loudness of the heart sounds, by acceleration of the heart's action, by variability of the pulse, and by want of clearness of the heart sounds at the apex or base. A constantly rapid pulse is of some importance for the early diagnosis of tuberculosis; also it is a very valuable prognostic sign. A fall in the blood-pressure also indicates activity of the disease, and is usually associated with clinically progressive tuberculosis. The prevention of functional heart symptoms is assisted by the proper treatment of tuberculosis and its toxic manifestations, especially by the addition of specific treatment to the general hygienic measures.

3. TUBERCULAR PERICARDITIS.

Anatomical Changes and Symptoms.

The changes consist of a deposit of whitish-grey granules, chiefly on the inner surface, which lead to chronic inflammatory adhesions between the pericardium and the epicardium, or to an effusion. The fluid may be serous, purulent or hemorrhagic.

Tubercular pericarditis may come on acutely or gradually; in the first case the symptoms being pains, breathlessness, cyanosis, and irregularity of the pulse. Later more severe dyspnoea, angina, vomiting and hiccough either lead to a rapid termination, or the case may subside into the chronic stage. The chronic cases are complicated with adhesion of the pleural surfaces.

It is rarely a primary disease, being usually secondary to tuberculosis of a neighbouring organ, such as the glands or pleura; tubercular mesenteric glands may also perforate into the pericardium. Sometimes it occurs as part of a miliary tuberculosis; also simple cases of pericarditis may become tubercular. Elderly persons are most often affected.

Diagnosis.

On physical examination a pericardial rub, especially at the apex, increasing enlargement of the cardiac dulness, weakening of the apex beat, and faint cardiac sounds may be detected in the acute form. In chronic cases enlargement of the cardiac area with absence of the respiratory displacement of the lungs, systolic retraction of the apex, inspiratory swelling of the veins of the neck and a paradoxical

pulse indicate adhesions of the pericardial surfaces. The pulsus paradoxus is produced mechanically; the pulse wave falls during inspiration, rises during expiration, and is highest in the respiratory pause.

The diagnosis of adhesive tubercular pericarditis thus depends on the following points: great congestion, oedema of the upper and lower parts of the body, and after the night's rest frequently also of the face, marked dyspnoea, enlargement of the liver and ascites, systolic retraction of the apex and the intercostal spaces, paradoxical pulse, inspiratory swelling of the veins of the neck, diastolic collapse of the veins not being characteristic, and abnormal respiratory movement, since the normal displacement of the anterior (chest) wall forwards and upwards is much hindered. In doubtful cases a cardiogram may assist in the recognition of the condition.

An exploratory puncture may give information in exudative pericarditis. A hæmorrhagic effusion indicates that the pericarditis is probably tubercular, especially if phthisis is also present and cancer can be excluded. Tubercle bacilli can only be rarely discovered; if the lymphocytes reach 50 per cent. or more of the cells in the fluid it is indicative of tuberculosis.

To examine the lymphocytes a thin smear of the fluid should be made on a cover-slip, fixed by drying in the air, and stained with Koller's methylene blue.

Treatment.

The treatment of acute tubercular pericarditis consists of absolute rest in bed, the application of an ice-bag, and limitation of the intake of fluids. In the chronic form of pericarditis, to prevent the formation of adhesions, W. Alexander proposed to introduce nitrogen gas into the pericardial sac until the inflammation subsides.

Effusions may be drawn off, if necessary, repeatedly. The trocar may be introduced obliquely inwards in the fifth or sixth intercostal space at the left border of the pericardium just outside the mammary line; with the patient on his back in a raised position the effusion is to be very carefully drawn off. If repeated removal of the fluid causes no improvement, Wenckebach recommends that sterile air should be introduced, to about half the volume of the fluid that is withdrawn. The formation of fluid then gradually entirely ceases, and what is of great importance the formation of adhesions is prevented.

For severe pains narcotics must be exhibited with heart tonics; a subcutaneous injection of $\frac{1}{4}$ c.c. of 1 per cent. morphia with $\frac{1}{4}$ c.c. of diligen may be recommended. For congestion and

cedema digitalis, caffein and diuretin are indicated, for cardiac weakness stimulants.

4. TUBERCULAR MYOCARDITIS.

Anatomical Changes and Symptoms.

The myocardium in cases of chronic tuberculosis frequently undergoes changes. In one-third of the cases of chronic phthisis V. Leyden found changes in the myocardium, resembling those met with in other infectious diseases. French authors, especially Raviart, Teissier, and others, consider the slight interstitial and parenchymatous lesions of the heart muscle to represent a specific toxic myocarditis, and explain with Poncet the absence of all specific histological appearances by saying that the condition is not due to the direct action of bacilli but to a remote effect of the tubercular toxin. Liebermeister was able in seven cases of such myocardial changes to demonstrate in six tubercle bacilli by animal inoculations. This seems to indicate that the heart muscle not being a particularly favourable spot for the deposition of tubercles, an extremely weak infection, such as occurs as a result of the bacillæmia of phthisis, may cause chronic inflammatory changes, without any specific tubercular formations.

But the myocardium may also be primarily affected by the formation of solitary tubercles in the wall of the ventricle. Also caseous degeneration of the cardiac muscle has been observed as an isolated form of tuberculosis; or the heart muscle may be thickly studded with tubercular granules and larger circumscribed caseous nodules without implication of the pericardium. More common is the extension into the heart muscle of tubercular disease of the pericardium; numerous nodules, thickest in the auricles, especially the right, may be found.

The symptoms of tubercular myocarditis consist of cyanosis, dyspnoea, and other signs of heart failure. It generally runs a chronic course, and affects especially young people.

Diagnosis.

The diagnosis usually causes great difficulty. Primary cases can only be suspected. Sometimes a weak, irregular, apical murmur and an accentuated second pulmonary sound may be heard. With extensive disease the heart is much enlarged. Cornet considers quickly changing murmurs and the rapid occurrence of severe collapse and cedema of the lungs to be pathognomonic.

Treatment.

The treatment does not differ from that of non-tubercular myocarditis, and consists of rest, ice-bags, digitalis preparations and stimulants.

5. TUBERCULAR ENDOCARDITIS.

Anatomical Changes and Symptoms.

The views as to the occurrence of endocarditis of a specific nature without histological tubercular tissue are the same as for myocarditis. Hanot, Potain, and others uphold the view that the toxin circulating in the blood may produce changes in the valves; and the tubercular origin of many cases of valvular disease, especially mitral stenosis, is beyond doubt. Dor was able, in a papillary excrescence on the mitral valve of a phthisical patient, to demonstrate tubercle bacilli by animal inoculation, although histologically no tubercles could be detected. The objection could be raised that such tubercle bacilli were only accidentally deposited on the valve from the circulating blood. But the experiments of Bernard and Salmon do not support this objection; by direct injection of tubercle bacilli into the artery of a dog they produced small white beads on the endocardium of the left ventricle, which did not show microscopically a distinct tubercular character, but were like those found in spontaneous endocarditis.

Tubercular endocarditis shows itself in various forms; as a verrucose valvular tuberculosis, in which Heller and others have found tubercle bacilli, as tubercular nodules on the mitral valve, and as a polypoid growth on the papillary muscle or endocardium, projecting into the vessel and analogous to one form of tuberculosis of the vessels.

Tubercular endocarditis occurs most often in young children in association with milary tuberculosis. Clinical signs may be entirely absent; but when the disease affects a valve, the usual cardiac symptoms may be produced.

Diagnosis.

A definite decision, whether a case of endocarditis is tubercular or not, is hardly possible; but the existence of the specific form must be remembered. Endocarditis and tuberculosis by no means exclude each other, as was formerly thought. It has been clearly proved by animal experiment that tubercular endocarditis may be set up as a result of injection of tubercle bacilli, if the valves are previously slightly injured. The existence of a tubercular endocarditis may be supposed if endocardial murmurs, which are neither due to articular rheumatism nor to anaemia, can be detected at the same time as tubercle bacilli in the blood.

Treatment.

There is but slight tendency to healing. Treatment must be directed towards maintaining the strength of the heart and favouring compensation. There is as yet no experience of specific treatment; a careful trial

would be justified in consideration of the powerlessness of other methods.

6. TUBERCULOSIS AND THE LYMPH-STREAM.

Anatomical Changes and Symptoms.

The lymph is even more closely associated with tuberculosis than the blood. We need only mention here the habitus lymphaticus, lymphatism, and the exudative diathesis as transitional forms between the scrofula of children and tuberculosis, also the importance of the lymphatic spread of tuberculosis, and the entry of tubercle bacilli into the lymph-stream of the thoracic duct. The last has been observed without the wall of the duct being affected.

Tuberculosis of the thoracic duct appears in the form of more or less widely-spread small nodules, which on softening discharge an enormous number of bacilli into the circulation, and thus may form the starting point of miliary tuberculosis.

The lymphatic vessels of the extremities, when affected by tubercular inflammation from their periphery, become changed into thickened, firm tubes, sometimes containing pus.

Diagnosis.

The discovery of tubercle bacilli in the lymph-stream can hardly be made during life. If the tubercular lymphatic vessels are superficial they may be felt as nodular or beaded strings adherent to the skin. Their meaning cannot be doubtful if they occur near a tubercular focus; but if this cannot be found they must be distinguished from syphilitic or carcinomatous lymphatics.

Treatment.

The treatment of tubercular lymphatics consists in their timely operative removal, along with the focus from which they originate. The whole organism must then be treated on general hygienic and specific lines.

7. TUBERCULOSIS OF THE LYMPHATIC GLANDS.

Anatomical Changes.

The lymphatic glands, connected with the lymphatic vessels, thanks to their adenoid tissue and richness in lymphoid cells, seize upon and render innocuous entering tubercle bacilli at the cost of becoming themselves diseased. The primary form of the disease is due to the fact that the glands act in a great measure as a filter for the tubercle bacilli, and that those near the point of entrance do not allow the tubercle bacilli to reach the blood-stream or to infect other groups of glands, without themselves becoming diseased. There-

fore in cases of primary disease of the glands the place of infection must be looked for in the region or organ, the lymph from which passes to those glands. There is another possibility of primary affection of the lymphatic glands through the blood-stream as described by v. Baumgarten. Even if there are only very few bacilli in the blood they have a special tendency to attack the glands. Since this occurs particularly in congenital tuberculosis, v. Baumgarten considers that many cases of tubercular gland disease have a congenital origin.

The causes of the secondary forms of glandular disease are clearer. If once the glands become infected the disease may spread in stages from gland to gland. The infection spreads from a primary focus in the lungs, bones, skin, &c., by means of the lymph- or blood-stream, or by contact, to the regional lymphatic glands. The recognition of this secondary glandular infection may lead to the detection of the primary disease.

Pathologically, the tubercular disease in the glands may be either recent or old and calcareous. The bacilli entangled in the meshes of the reticulum usually set up in three to six weeks a swelling and distinct infiltration of the gland. Then central caseation occurs, and this may either soften and break down, or calcify. Even very slightly enlarged glands may contain in their parenchyma the smallest caseous foci, which may completely calcify or be enclosed in a fibrous capsule, so that they are no longer dangerous to the organism. If calcification or encapsulation does not occur, or if the tubercular focus breaks into the surrounding tissue, a hollow cavity, a vessel, or exteriorly, the tubercular virus will be spread. Even calcified lymphatic glands may contain bacilli in a virulent state.

Symptoms and Course.

The clinical symptoms of tuberculosis of the lymphatic glands vary with the position of the glands. While infection of the external glands causes inflammatory swelling which can be seen and felt, and later redness and pain, tuberculosis of the internal glands often causes no, or only indefinite, symptoms. Tubercular changes at the point of entrance of the bacilli may accompany the enlargement of the glands. On the other hand, the organisms may pass through skin or mucous membrane, which is intact to the naked eye, without leaving behind any traces.

If tubercular glands break externally a sinus is left, and tubercular ulcers may form along its track or at its external opening. At first bacilli can be rarely found in the discharge; with the growth of granulations the form of tubercle bacillus not staining by Ziehl's method appears.

Primary and secondary tuberculosis of the lymphatic glands can be distinguished. Both have a great theoretical and practical importance, since the development of tuberculosis of an organ from a primary glandular tuberculosis is even more certain than the occurrence of a secondary glandular infection from primary disease in an organ. It is worthy of remark that primary glandular tuberculosis has its greatest importance in childhood. With increasing age it becomes more rare, and in adults the glands are usually affected secondarily during the course of a chronic tubercular disease.

Diagnosis.

Whether as many as 90 per cent. of all adults, as Naegeli, Lubursch, Schmorl, Hamburger, and others have said, are affected with tuberculosis, or only a smaller percentage, the fact remains that the lymphatic glands are the structures far most frequently attacked. This frequency makes it impossible to enter into the diagnosis of all the different varieties. We may limit ourselves to the consideration of the bronchial and mesenteric glands, as types of internal glandular tuberculosis, and of the glands of the neck, as typical of surgical tuberculosis of the glands. Also the condition will be only described as it affects adults; children are separately considered in Chapter XV.

Bronchial gland tuberculosis is usually present, if there is any tubercular disease in the body (Hamburger). Primary disease is rare after the age of puberty; but it is also possible in adults for the endothoracic glands to become first affected, or for glands, which were infected in childhood and remained latent, to be the seat of active and manifest tuberculosis as a result of certain conditions, such as other infections, weakening diseases, traumas, &c. If the tracheo-bronchial glands, which receive the lymph from the lungs and the lower part of the tracheal mucous membrane, and are connected with the supraclavicular glands, become much enlarged, pressure symptoms will be caused. These vary according to the involvement of neighbouring nerves or organs. Pressure on the vagus may cause cough and vomiting; on the recurrent laryngeal paralysis of the cord and hoarseness; on the sympathetic dilatation of the pupil on the affected side; on the trachea and bronchi oppression, dyspnoea, even orthopnoea and asthmatic attacks; on the superior vena cava fulness of the veins of the neck and chest, oedema and cyanosis of the face; on the aortic arch hypertrophy of the heart; on the pulmonary veins congestion and a tendency to bleeding from the nose; and on the œsophagus dysphagia. Of the remaining signs Philippi puts those in the first rank which can be always detected in cases of

tuberculosis of the bronchial glands, and in the second those which are only met with in some cases. The signs of the first rank include: extensive vertebral dullness between the spine and the scapula, which is separated by a resonant zone from the usual apical dullness; also parasternal dullness, usually most marked in the second intercostal space; shortening of the nose over the corresponding vertebrae; marked increase of resistance especially over the hilus dullness; breath sounds of a more or less bronchial character, often accompanied with crepitations on loud coughing; increase of bronchophony; a positive result on Röntgen-ray examination, consisting of lines of peribronchial infiltration. With active disease there is always also marked leucocytosis, which is increased by a tuberculin injection; the temperature is generally changeable, subfebrile, or intermittent; the *v. Pirquet* reaction is positive even with weak tuberculin solutions; and pleurisy of the margins of the pleura, which frequently relapses, is common. As symptoms of the second order Philipppi includes pains in the back or front, tenderness on pressure, especially over the neighbouring vertebrae, paroxysmal dyspnoea, irregularity of the heart, alterations in the movements of the vocal cords, paroxysms of cough, stabbing pains in the side, pallor of the skin, various bronchitic signs, increase of vocal fremitus, want of clearness in the heart sounds over the large vessels, and accentuation of the second sound over the dull area.

The differential diagnosis must be made from other forms of mediastinal tumour. The history, a sufficiently thorough examination of the lungs, the Röntgen-rays, and particularly the result of a test tuberculin injection will make the distinction possible. E. Neisser recommends palpation with a sound, direct pressure of which from the oesophagus may cause pain in the swollen bronchial glands.

Tuberculosis of the mesenteric glands in adults usually arises from the caecum, more rarely from tubercular disease of the pelvic organs or the vertebrae, and produces hyperplastic nodular masses, which may be easily felt if the abdominal wall is relaxed. According to the observation of the surgical clinic of Jena these glandular masses are usually found in a triangular area, whose base is formed by the caecum and lower part of the ileum, and whose apex is at the second lumbar vertebra. Occasionally the course is acute, leading to perforation and peritonitis; usually the symptoms are indefinite, and consist of pains in the right side of the abdomen, perhaps spreading to the back, obstruction or diarrhoea, wasting and anaemia. As the neighbouring parts become implicated the same symptoms are produced as by all

inflammatory conditions which affect both the peritoneum and bowel; and then the diagnosis is most difficult. A palpable tumour if formed may resemble many other conditions (cyst, lipoma, and echinococcus of the mesentery, aneurysm of the aorta, ovarian tumour, fetal pregnancy, movable kidney, and various diseases of the vertebra). Even a recognition of the exciting cause of the disease will only indicate the actual condition to a certain extent.

Tubercular glands in the neck may be felt as hard nodules of the size of a bean to a walnut. They may remain for long unaltered, or may penetrate between the soft parts of the neck, become adherent to the skin and their surroundings, or under the influence of bacteria from the mouth and throat they may soften and discharge exteriorly. Very rarely does tuberculosis produce large masses of glands in a short time, like scarlet fever and diphtheria.

The differential diagnosis, whether swellings of the superficial glands are due to tuberculosis or syphilis, lymphosarcoma or lymphatic anemia is often very difficult. Syphilis can be recognized by the history of the primary disease, the presence of other syphilitic symptoms, and the result of treatment. Lymphosarcoma does not respect the limits of the glands, but breaks through into the neighbouring structures; microscopically the tumour formation is characteristic. True lymphatic leukemia causes painless swelling of the glands and hyperplasia of the spleen and the bone marrow (as shown by the blood-cells), while in tuberculosis tenderness of the glands and fever are common, there is no swelling of the spleen or changes in the blood-cells. The tuberculin test here leaves us in the lurch, as leukemic, like tubercular glands, may give a reaction. Hegeler has observed an enormous swelling of leukemic glands from 2 c.mm. of tuberculin.

Prognosis and Treatment.

The prognosis of primary lymphatic tuberculosis is better than of secondary, since in the latter the presence of the original focus indicates a more widely spread disease.

The treatment must be based on general hygienic measures. To these may be added tuberculin, which should never be omitted in primary cases on account of its excellent results. Also in secondary disease of the glands a combination of specific and general measures will often lead to recovery.

Small, superficial glands, which have not yet softened, may also be treated with cod-liver oil, iodides, and creosote per se internally, and 10 per cent. iodoform ointment or iodovasogel externally; though much must not be expected from their use.

Measures which produce marked irritation of the skin, especially painting with iodine, are better left alone. Frictions of the whole body with soft soap have, according to Kappesser, a good effect.

Lately tubercular glands have been considered to be especially suitable for Röntgen-ray treatment. According to Leonard the rays first destroy the tissue of the lowest vitality and development and convert it into connective tissue; thus the isolated nodules may be absorbed, and at the same time extension and breaking down are prevented. The local application of the rays has also a general action; it probably sets free an autogenous vaccine or antibody. It is the general experience in Germany and elsewhere that tubercular glands, whether in the stage of simple hyperplasia, or if partly suppurating, caseating, and ulcerating may be favourably affected by the rays. The stage of hyperplasia gives ideal results; the glands without exception become converted into fibrous nodules; radiotherapy is here slower but more thorough than an operation, since the smallest glands are also attacked. It has been stated, not without grounds, that extensive glandular resections produce a marked diminution of the immunization of the organism, as shown by a very positive *r.* Pirquet reaction, and thereby open the way to fresh infections. Also the rays avoid the unsightly scarring of the neck in young individuals. Radiotherapy has, too, a cosmetically good effect on suppurating, caseating, or ulcerating glands. Unbroken suppurating glands can be treated by letting out the pus through quite a small incision, and then applying the rays. Sometimes a sinus forms, but it closes in four to five weeks. Also broken down glands that have already formed a fistula give with deep irradiations very fair results, especially compared with the ugly scars left after operations. The more superficial are the glands, the quicker do they subside. But it is also possible to affect even deeplying glands, such as the tracheo-bronchial and mesenteric, with the rays, and to reduce them considerably. The X-ray treatment of glandular fistulae is superior to all others. Here there is a marked tendency to cicatricial contraction; the sinus sometimes closes too soon, that is so quickly that some discharge may be pent up. Therefore in cases of deep glands the fistula should be kept open with a drain-tube till the nodule is healed. Of course the Röntgen treatment must be learnt and practised. The command of a reliable apparatus is necessary; and, above all, the dosage must be attended to. It is also obvious that general and medical treatment must not be neglected at the same time. The best results are given by a combination of Röntgen and tuberculin treatments, accompanied by diet, salt-baths, and sea or mountain air.

If in spite of these measures the glandular tumours do not subside, or if they increase or lead to functional disturbance of some organ they must be removed surgically, if possible before they soften, become adherent to the skin, and reach such a size that their removal would entail extensive scarring. Mohr recommends that after the removal of tubercular glands the congestion treatment should be employed to avoid complications or relapses. Softened glands may be treated with aspiration, followed by injection of 1 to 2 c.c. of 10 per cent. iodoform-glycerine, or by the suction method, only a small incision being made. Operation may be more readily performed on adults than on children, since in the former the glands seldom subside, and caseate more rapidly.

Tubercular bronchial glands in the hilus of the lung, in spite of the difficulty of access and propinquity of nerves and vessels, do not remain *non tange* for the surgeon. Thus Riedel removed from a patient aged 40, after a preliminary plastic thoracic operation, a caseous and calcified bronchial gland of the size of a pigeon's egg, which was causing an abscess and fistula; he employed drainage, and obtained healing.

The treatment of mesenteric glands, which are complicated by disease of the intestinal canal, is surgical. Isolated tubercular glands in the region of the caecum, after preliminary treatment with the Röntgen rays to render them anæmic, may be removed. When lymphomatous masses are diffused through the whole mesentery of the small bowel, at most the glands in which the disease is farthest advanced may be removed, which may have a good influence on those remaining.

8. TUBERCULOSIS OF THE SALIVARY GLANDS.

Anatomical Changes.

Tuberculosis of the salivary glands may appear as disseminated irregular nodules, or as a large, firm tumour of the size of a goose's egg, which may caseate or become filled with mucoid saliva. In the first case mumps with abscess formation may be simulated, in the second tumour or cyst. Histologically epithelioid and giant cells are to be found, the latter being derived from the glandular epithelium.

Symptoms and Course.

The disease usually occurs in the parotid, much more rarely in the submaxillary gland. In any case it is very rare, only about twenty cases being known, and usually occurs in otherwise healthy people as a primary disease. It usually remains entirely local and runs a very chronic course.

The bacilli may enter by a carious tooth, an affection of the

gum, such as stomatitis and gingivitis, and probably also by the tonsil. The infection is carried by the lymph- or blood-stream, or travels up the duct to the gland. The tumour is generally quite indolent; not infrequently it causes neuralgic pains in the side of the face, the head, the eye or the ear. It may lead to a fistula. The regional cervical lymphatic glands always participate.

Diagnosis.

The freely movable, firm, doughy, or fluctuating swelling is but little characteristic. Facial paresis and paralysis have been observed. The disease must be diagnosed from dermoid cysts, fibrosarcoma, syphilis, actinomycosis, and epidemic parotitis by a tuberculin injection or by a bacteriological or histological examination.

Lately tuberculosis has been recognized as the cause of Mikulicz's disease—a symmetrical swelling of the lachrymal and salivary glands. At least in certain cases, according to Fleischer, Mikulicz's disease is nothing but a peculiar, modified form of tuberculosis. The earlier idea of its connection with pseudo-leukæmia is not confirmed.

**Prognosis and
Treatment.**

Since the disease is almost always primary, the prognosis is good. The treatment consists in an attempt to remove all the diseased tissue by operation; it may lead to complete recovery.

9. TUBERCULOSIS OF THE THYROID GLAND.

**Anatomical
Changes.**

In phthisical patients the thyroid gland, apart from the frequent slight enlargement in the early stage, sometimes undergoes sclerosis of a non-specific nature, no doubt as a result of toxæmia; in many cases this explains the tachycardia, and in others the marked tendency to adiposity. The specific changes consist of miliary granules scattered through the whole gland, or in one part of it. Solitary or multiple, larger tubercular nodules with caseation are rarer.

Experimentally the thyroid gland, like the spleen, kidney or testicle, can be infected by direct injection of a small number of bacilli. Its susceptibility is, however, slighter, probably on account of its specific functional activity.

**Symptoms and
Course.**

The miliary form may be quite without symptoms, and may not even produce a perceptible enlargement. In other cases there may be distinct hardening to be felt, or there may be soft, fluctuating enlargement. The general condition is not thereby altered. Pains are absent, or are slight. Considerable swelling—it has been seen as large as a child's head—leads to pressure

symptoms, such as stridor, difficulty in breathing or swallowing, hoarseness, paresis of the vocal cord, and alterations of the pupil. The neighbouring lymphatic glands are generally swollen.

It runs an indefinite course. Chronic swelling may remain for months, or mixed infection with gains and fever may occur after some weeks. Breaking of a focus into a thyroid vein causes general miliary tuberculosis.

Primary disease has not been observed. It regularly forms part of miliary tuberculosis. Infection of the thyroid may occur secondarily from pulmonary tuberculosis, and also frequently from disease of neighbouring lymphatic glands.

Diagnosis. The diagnosis depends upon the presence of tubercular disease in some other organ, on the enlargement of the thyroid, its tenderness and painfulness, on compression symptoms and on swelling of adjoining lymph glands. The differential diagnosis must be made from carcinoma.

Prognosis. The prognosis is good in cases of isolated nodules, but if the whole gland is affected it is doubtful on account of interference with the glandular functions (myxoedema, cretinism).

Treatment. The treatment of single nodules is surgical, and in the other varieties symptomatic. French authors recommend that in all cases of tuberculosis in which there are signs of deficient thyroid secretion, the patient should be carefully treated with thyroïdin.

10. TUBERCULOSIS OF THE SPLEEN.

Anatomical Changes.

The most common non-specific alteration of the spleen in phthisical cases is amyloid degeneration (sago spleen).

The tubercular spleen presents different appearances according to its development being rapid or gradual; it may be uniformly full of countless small nodules, or irregular tubercle conglomerations of a caseous or suppurative nature may be formed, or both conditions may be present at the same time. The spleen is often enormously swollen, the surface is smooth, or may be slightly uneven or nodular. On microscopical examination giant cells can be regularly found, and tubercle bacilli not rarely.

Symptoms and Course.

The spleen is always affected in acute general miliary tuberculosis; on the other hand, it is only rarely so in the ordinary course of chronic phthisis in adults. This is in striking contrast with the regularity with which it is affected in the other infectious diseases. It suggests that not only does the spleen destroy bacteria, but that it also produces during the course of chronic

tubercular infections protective, anti-tubercular substances, which account for the slight disposition of the organ for tuberculosis. Secondary tuberculosis of the spleen hardly causes any clinical symptoms.

On the other hand, primary splenic tuberculosis, according to the publications of recent years, is a more frequent disease, the recognition of which is important, as a timely operation may lead to complete recovery. The following symptom complex has been described: Splenic tumour, considerable augmentation of the red cells, and cyanosis. But it must be remarked that it is only the splenic tumour which is characteristic of tuberculosis, since the cyanosis is generally not marked and the increase of red cells may be absent, and may occur from other causes. With the splenic tumour haemorrhagic ascites has been observed. Fever, wasting and general symptoms may be present or absent.

Tubercular perisplenitis is of little importance clinically; it leads to firm adhesions, and shows itself occasionally by friction, which can be felt and heard.

The course of tuberculosis of the spleen is usually chronic; acute cases end quickly in death.

Diagnosis.

The diagnosis is difficult, especially that of the primary form, and in many cases impossible. Not infrequently it is first made from the examination of an extirpated spleen. A test tuberculin injection may help to distinguish between chronic splenic hypertrophy and tuberculosis. If this is contra-indicated or fails an exploratory laparotomy remains as a last resource.

The differential diagnosis must be made chiefly from the other splenic tumours; leukaemia (by the blood examination), pseudo-leukaemia (rather more chronic course, no fever, no tubercular antecedents), malaria (history and blood examination), syphilis (history and Wassermann's reaction), amyloid disease of the spleen (chronic suppurative disease in some other organ), Banti's disease (blood examination, cirrhosis of liver). Other tubercular symptoms and signs are in favour of tuberculosis.

Prognosis.

The primary disease has not a bad prognosis if submitted to timely operation; the secondary form is hopeless, being a sign of general infection.

Treatment.

The treatment of the primary disease consists of extirpation. The operation is not only indicated by the good results given, but by the powerlessness of all other therapeutic measures; according to the experience that has been acquired the spleen is not an indispensable organ and may be sacrificed when required. But the splenectomy must be done in time before the disease has spread to the liver. There

are fourteen cases of extirpation of the spleen for primary tuberculosis recorded, of which five were fatal. According to Kummell, the mortality of early splenic removal is reduced to 12 per cent.; proper technique will give even better results.

II. HODGKIN'S DISEASE.

Anatomical Changes.

The most important anatomical changes of Hodgkin's disease, also known as pseudo-leukaemia (Sternberg) or lymphomatosis granulomatosa (E. Fraenkel) are situated in the lymphatic glands, both internal and external, and the spleen. The glands are considerably enlarged, and on section present a dull-grey, homogeneous, hyaline appearance, with yellowish white spots, also white, fibrous nodules of connective tissue. Softening and suppuration are either absent, or if they occur as a result of bacterial infection never affect the whole of the diseased gland. The spleen is generally enlarged, with bosses on the surface, and on section has an appearance so characteristic that it by itself indicates the disease. Its appearance has been likened to hard-hale or porphyry, that is to say, in the dark-red splenic pulp are embedded numerous, large, prominent, round, angular or irregular masses, grey-white in colour, isolated or in groups. Similar nodules to those in the spleen have been found in the marrow of the long bones and especially the vertebrae, and perhaps also in the liver, lungs and other organs. The lymphatic tissue in the throat and intestinal tract remains unaffected (E. Fraenkel). According to Sternberg's observation the nodules consist microscopically of inflammatory granulative tissue, containing small and large lymphocytes, numerous eosinophile cells and plasma cells in variable number, also large epithelioid cells and peculiar giant cells, entirely different from Langhans type. This tissue displaces the normal parenchyma; gradually at spots it necroses, while at other places there is a tendency to the formation of fibrous tissue.

The aetiology of Hodgkin's disease is not yet fully explained, though E. Fraenkel was able, in sixteen out of seventeen cases, to find rods and granules, which were antiformin fast and Gram-positive, but not acid-fast, and morphologically could not be distinguished from Much's granular form of the tubercle bacillus. Therefore the virus of Hodgkin's disease is not identical with Koch's tubercle bacillus, but resembles it very closely, and in this E. Fraenkel's view approaches the older one of Sternberg.

Symptoms and Course.

Hodgkin's disease attacks first of all only one group of glands, generally those in the posterior triangle of the neck, which enlarge, usually painlessly, and remain for weeks or months of

the same size. Then they begin, without obvious cause, to increase again, and now the lymphatic glands in other parts of the body begin to swell, such as those in the supra-clavicular fossa, the axilla, the groin, the thorax and the abdomen, without following any definite order. The glands may become adherent to each other and to the skin and suppurate, if other infection occurs, but never of themselves; several may become firm and hard and diminish in size, while the rest remain swollen. The infection chiefly enters through the mouth. The course of the disease is usually chronic; the average duration being from twelve to eighteen months. It most commonly occurs between twenty and forty, men being affected rather more often than women.

Diagnosis.

In Hodgkin's disease, besides the enlargement of one or more groups of glands, there are several other signs, which although not constant may help in the diagnosis. Frequently a firm splenic enlargement can be discovered, which has neither the size nor smooth surface of that of myelogenous leukaemia. Another sign of importance, although present only in a proportion of the cases, is chronic relapsing fever, an intermittent type of fever, broken by periods of complete apyrexia, lasting for months. In other cases the fever runs a remittent or quite irregular course. The condition of the blood is by no means constant; in some cases there is an obvious polynuclear leucocytosis, which is of special diagnostic value if there is distinct eosinophilia; but there are also cases in which there is diminution of the white corpuscles. The tuberculin test is not distinctive, since the glandular tumours react in both tuberculosis and Hodgkin's disease. In such doubtful cases a histological examination may be made of a portion of excised gland; the appearances that have been described clear up the diagnosis. But if there is no perceptible enlargement of the peripheral lymphatic glands the disease will usually remain unrecognized.

Prognosis and Treatment.

The prognosis is thoroughly bad. The afebrile intervals must not be taken to mean subsidence of the disease. After months or years the patient is carried off by anaemia, cachexia, or some complication, not directly connected with the disease.

Hodgkin's disease can be influenced neither by surgical nor medical treatment. Tuberculin, Röntgen-rays, and salvarsan have all failed, according to the experience in the Hamburg-Eppendorf hospital. The good results described by Nagel from the administration of arsacetin, E. Fränkel considers not to have been proved.

CHAPTER VIII.

Tuberculosis of the Skin.

Besides the specific tubercular affections of the skin, in the course of so chronic a disease as tuberculosis there are certain non-tubercular changes of the skin and its adnexæ, which occur in consequence of its deficient functional activity in connection with the lowered nutrition, and which have some symptomatic value.

The best known non-tubercular affection is *pitryasis versicolor*, produced by the *Microsporum furfur*, which has a predilection for the badly nourished, easily perspiring skin of phthisical patients. The fungus, which grows only in the most superficial layers of the epidermis, attacks chiefly the chest and back, and there produces yellow or brown spots of varying size, which may join together to form large areas. In slight cases the spots will disappear with special attention to the skin and energetic application of soap. If this is insufficient, or if extensive areas of skin are involved, then more powerful chemical agents must be used, of which there are many of utility. The most frequently used are iodine, oil, and spirit of turpentine, 5 to 10 per cent. pyrogallie acid ointment, 10 to 20 per cent. crysazolin ointment, tar and sulphur as soap or ointment, and salicyl and resorcin ointments alone or combined. To prevent relapses the application must be used for a very long time, and the skin carefully watched. Of special importance is the disinfection of the linen and clothes.

An undoubted nutritional disease of the skin is *pitryasis rubescens*, which may attack consumptives like other cachectic patients. The skin is dry and brittle, the superficial layers of the epidermis scale off, leaving a smooth, lustreless surface, which seems dusty. The treatment must be directed against the cause of the malnutrition. The troublesome tenderness of the skin often requires local treatment by frictions with mild ointments or oils after a luke-warm bath.

Yellow or brown spots of pigment, *chloasma phthisicorum*,

often appear on the face, especially the forehead, the cause of which, as in other cachectic diseases, is not sufficiently explained.

Alopecia capillitii is to be explained by the general cachexia, like the other atrophies of the skin. The hairs become atrophic, fall out, and in the last stages of phthisis produce complete baldness.

The peculiar curvature of the nails is associated with circulatory disturbance, and is often observed in phthisical patients in association with congestion of the pulmonary circulation. It was known to Hippocrates, and the condition has been termed by French authors the "hippocratic finger." The phenomenon is one stage of the clubbed (drum-stick) finger, which has the same aetiology.

The special varieties of cutaneous tuberculosis may be divided into two groups: the bacillary forms of tuberculosis of the skin, and the tuberculides.

A.—The bacillary tubercular affections of the skin are those in which the bacilli can be discovered. The skin is very resistant to the tubercle bacillus; according to recent experiments on the unbroken skin, the bacilli will pass through the hair-follicles into the lymphatic spaces, without producing any local disease, which only occurs if the skin is first injured (Koenigsfeld). As the skin does not offer a favourable ground for their development, usually only a few bacilli will be found in serial sections. Probably the low temperature of the skin is one cause of this. Much more frequently than tubercle bacilli Much's granules and rods have been recently found; for example, H. Boas and Ditlevsen only succeeded in finding bacilli staining by Ziehl's method four times in twenty cases of lupus, while in all Much's forms were found, especially in the giant cells. The most important of the true tubercular diseases of the skin are:—

- (1) Tuberculosis cutis propria.
- (2) Scrofuloderma.
- (3) Lichen scrofulosorum.
- (4) Tuberculosis cutis verrucosa.
- (5) Tuberculosis cutis necrogena.
- (6) Lupus vulgaris.

I. TUBERCULOSIS CUTIS PROPRIA.

Anatomical Changes and Symptoms.

Miliary tuberculosis of the skin was first observed in the dead body, histologically examined and described by Charrin.

A careful clinical observation was made of this disease by Kaposi, whose name is often given

to it. In the early stages small, light-red or brownish-red, scaly nodules, or comedo-like bodies of the size of a poppy-seed, are found; they break down into milium ulcers, which join together to form the typical ulcers of milium tuberculosis of the skin. These characteristic ulcers are situated especially at the junction of skin and mucous membrane, at the mouth, the anus, and the urethral orifice; they usually grow out from the mucosa, and affect the skin by continuity. The ulcer is superficial, the base is covered with indolent, pale-red granulations, the edges are jagged and eroded. At the base and edges of the ulcer may be seen single or numerous small, comedo-like granules, the true milium tubercles. In the tissue and discharge tubercle bacilli can usually be found easily; they may be missed in cases in which the tubercles necrose rapidly.

Ulcerating milium tubercle of the skin is usually a disease of adult phthisical patients, and is a result of auto-infection; it may take weeks or months to develop. Cases of exogenous inoculation tuberculosis are rarely observed.

In the literature there are described several cases of acute milium tubercle of the skin accompanying milium tuberculosis, which did not proceed to ulceration, but subsided spontaneously.

Diagnosis. The diagnosis is easy, if regard is paid to the primary cause. But also in the rare cases of primary inoculation tuberculosis the recognition of the characteristic skin affection was not difficult.

Prognosis. The prognosis depends on the primary cause, and is bad when it occurs in cachectic cases. In patients who are still capable of resistance it is not absolutely unfavourable, and cases of spontaneous recovery have been seen.

Treatment. When the primary disease still permits treatment, excision, cauterization or scraping, followed by caustics, may be employed.

2. SCROFULODERMA.

Anatomical Changes and Symptoms.

This form of tuberculosis of the skin consists of a superficial, firm, defined, nodular infiltration in the subcutaneous tissue, the *gumma scrofulosorum*. At first the skin is movable over the nodules, with increase in size, and softening of the nodules, the skin becomes adherent. The nodules raise the thinned and reddened skin, and break through at one or more points, forming a superficial, uneven ulcer,

covered by indolent, yellowish granulations, and having thin, undermined, eroded edges. The pus is a thin fluid, containing crumbly, necrotic masses; it dries into crusts, which do not usually remain long on account of the copious discharge. Tubercle bacilli cannot generally be found. In the neighbourhood new nodules form in a similar way, join together, and give rise to large ulcers, separated by bridges of healthy skin. These scrofulous ulcers may also form without previous nodules from suppurating or caseating lymph-glands, or from suppurative bone disease. Favourite sites are the neck near the mastoid process, the thorax, the bend of the elbow, the axilla, and the lower part of the leg.

Scrofuloderma occurs chiefly at puberty, but has also been seen in later years in scrofulous persons. It has a marked tendency to spontaneous healing, leaving smooth, pale, irregular cicatricial areas, separated by healthy skin. If the ulcer has been deep, especially in the neck, there will be marked cicatricial contraction.

Diagnosis.

In the nodular stage it may be confused with a syphilitic gumma, and in the ulcerative stage, if bacilli are absent, with a syphilitic ulcer. The following points may be helpful: the syphilitic gumma is very firm, tender on pressure, much less torpid, and prefers the skin over the forehead and tibia. The syphilitic ulcer has hard, infiltrated, steep edges, which are not undermined; it usually has a characteristic circular or kidney shaped outline, and has a tendency to progress rapidly. The syphilitic affections react to mercury and iodides.

Prognosis.

The prognosis of uncomplicated cases is good. If the ulceration is due to discharge from a gland or bone the prognosis depends upon the primary disease and the general constitution.

Treatment.

The general treatment consists of ordering a good diet, rich in albumens and fats, an open-air life, sun baths, and possibly a visit to the sea. For internal use there are cod-liver oil, iodides, and arsenic. As reabsorbents, especially if the scrofulous nodules have not yet broken down, frequent applications of soft soap may be used, which generally have a good effect also on the disease in glands or bones. The nodules may also be treated with other reabsorbents, such as mercurial ointment, iodine, potassium iodide, iodo-vasogen, ichthyl ointment, ichthyol ointment, &c.

The best local treatment is surgical, consisting of timely incision if softening can be no longer prevented, scraping out

the softened, necrotic masses, removing the undermined edges, so as to obtain a better cosmetic result, and plugging with iodoform, xeroform, or dermatol gauze. Disease in the glands or bones may be surgically treated at the same time. Recently the Röntgen-rays have been used with extremely good results (Holtknecht, Löwenberg).

3. LICHEN SCROFULOSORUM.

Anatomical Changes and Symptoms.

Lichen scrofulosorum is characterized by small papules or nodules, of a yellow, pale-red or livid colour according to their age; they are slightly raised and are arranged in groups. By Neisser the disease has been named "*tuberculosis milio-papulosa aggregata*." The consistency of the eruption, which nearly always develops in the hair follicle, is usually soft, but may be rarely firm. The surface is smooth and covered with loose, whitish scales. A hair often grows out through the papule; if it is broken off, a depression may often be seen in its place. By the confluence of a group of papules and by thickening of the scaly covering, plaques of various shape and size are often formed, resembling a rough, dry infiltration in which the separate papules are difficult to recognize.

The favourite sites of the eruption are the back and the abdomen, more rarely the extremities or the face. The papules develop very slowly, and may remain for months and then be reabsorbed. After this, however, they may relapse, lasting a very long time.

Severe cases may be complicated by scrofuloderma, lupus vulgaris, cold abscess, and lymphadenitis. Very often acne cachecticorum may also be found, especially in marasmic children. It has frequently been observed that the acne pustules may develop directly out of the lichen papules, wherefore this form of skin disease has been considered to be a variety of lichen scrofulosorum, and has been termed *scrofuloderma pustulosum*.

Lichen is found most often in scrofulous children. Recently it has been generally held to be a true tubercular affection of the skin, although not many authors have succeeded in finding tubercle bacilli or obtaining positive results from animal experiment. Besides the histological structure, the occurrence of a typical tuberculin reaction is in favour of its tubercular nature. According to Klingmüller's researches lichen may certainly be produced without the presence of bacillary elements or their debris by the action of the tubercular toxin alone.

Diagnosis.

The exanthem is very characteristic and easy to recognize. Nearly always other signs of scrofula are present. Papular eczema, in contrast to lichen scrofulosorum, causes much itching. Syphilitic lichen is more copper coloured, is arranged in segments of circles, and has a different localization. According to Neisser, Jadassohn, and others the lichen papules react to tuberculin, and after its use latent deposits in the skin may first become visible.

Prognosis and Treatment.

The prognosis of the local skin affection is quite good. The general treatment must be directed against the scrofulous constitution. Internally cod-liver oil, iodides, and arsenic may be used. Irritating ointments are condemned by most dermatologists. Recently tuberculin has been employed with good results; for example by B. Klingmüller in the Breslau skin clinic.

4. TUBERCULOSIS CUTIS VERRUCOSA.**Anatomical Changes and Symptoms.**

Tuberculosis cutis verrucosa was first described by Riehl and Paltauf as a true inoculation tuberculosis of the skin, generally situated on the hand or forearm, and occurring in healthy adults. The affection never begins as a lupoid nodule, but as a small, brown spot, covered with smooth, white scales, in which state it may remain for months. Later it develops into a round plaque. By the confluence of several plaques a serpiginous form is produced, which has a tendency to grow at its periphery. The plaques are surrounded by a thin red zone, within which are small pustules; in the centre are little warty nodules, which attain a height of 3 to 7 mm. Between the small nodules are erosions and pustules, from which drops of pus can be pressed. Lupoid spots cannot be found in the neighbourhood. The condition never leads to ulceration; it may either spread at the periphery, or subside spontaneously. It may last for many years. After spontaneous healing a thin, superficial scar, presenting a sieve-like appearance, is left.

The disease is produced by exogenous inoculation with tubercular material from phthisical patients, by auto-infection in tubercular individuals, by continuity from tuberculosis of glands or bones, and lastly, by infection with bovine bacilli.

Diagnosis.

The recognition of this very characteristic, extremely chronic affection is easy, as it can hardly be mistaken for other conditions.

Prognosis.

The disease usually remains local, and the prognosis is good. Infection of the lymphatics and regional lymphatic glands is rare.

Treatment.

The best treatment is excision, cauterization, or scraping, followed by the use of caustics. If surgical treatment is declined, Neisser recommends arsenical paste, Fahy a solution of salicylic acid and application of 10 per cent. salicyl-pyrogallie ointment, and Joseph 30 per cent. resorcin paste. These treatments are also successful, but are usually very slow. Good results are given by Finsen's light treatment, and weak doses of Röntgen-rays have, according to Schmidt, Holzknecht, Stern, Dietlen, and others led to healing without scar formation.

5. TUBERCULOSIS CUTIS NECROGENICA.**Anatomical
Changes and
Symptoms.**

Post-mortem tuberculosis, considered by many to be the same as tuberculosis verrucosa, which at all events it very much resembles, is found most frequently on the hand and forearm of anatomists, doctors, and mortuary porters. It appears as single or numerous nodules. It first comes as a small, circumscribed, red papule, on the surface of which a small pustule forms. The pustule dries, falls off, and leaves a slightly nodular base. The affection may appear to be healed, but usually a slight thickening can be felt at the spot, which in the course of a few weeks gradually increases, and develops into a warty, nodular, projecting tumour, with a thick horny covering.

The infection spreads from the sebaceous glands and their surrounding tissue. There is no doubt as to its tubercular nature. Whether a mixed infection favours its development is questionable. The local condition usually remains confined in the more superficial layers of the skin, but spread of the infection to the lymphatics often occurs. Since it usually appears in medical men, or in those closely in contact with them, its later developments are rarely seen.

Diagnosis.

The infection as such can be recognized quite early. The condition is very characteristic and unmistakable.

Prognosis.

Since the disease, in opposition to tuberculosis cutis verrucosa, has a tendency to spread to the lymphatics, the prognosis is serious if radical measures are not taken early.

Treatment.

This consists entirely in the earliest possible radical removal of the nodules by excision or cauterization.

6. LUPUS VULGARIS.

**Anatomical
Changes and
Symptoms.**

The most important, most polymorphic, and most difficult to treat of the forms of tuberculosis of the skin is lupus. It is the most obstinate of these infections, and may last for decades. The lupoid processes appear in the more superficial layers of the cutis, especially in the papillae. According to Jadassohn the infection of the skin may take place by exogenous inoculation, by auto-inoculation, by continuity, by infection through the blood, and by bovine infection. There are numerous reports of each method of infection in the literature. The correctness of the recent assertions from various sources that lupus generally depends on infection with the bovine type of tubercle bacillus, has small probability, on account of the close connection between lupus and tuberculosis of the internal organs; also the organism obtained from lupus tissue has usually the characters of the human type (in ten cases examined in the Berlin Institute for Infectious Diseases the human type was found seven times and the bovine type twice, while in one case human bacilli were found in one nodule and bovine in another).

The earliest sign of lupus, and one that is very characteristic of all its manifestations, is the lupoid nodule. The tubercle bacillus after its entry into the skin produces inflammation and infiltration, thus forming a tubercle; a conglomeration of such tubercles is the lupus nodule which can be recognized by the naked eye. It appears as a spot of the size of a head of a pin lying in the skin, and is of a light brown or brownish-red colour. In hyperæmic tissue it is very difficult or impossible to recognize. If a small glass slide is pressed on the skin, so as to make it bloodless, the spot will be more apparent. Another characteristic sign is the soft consistency of the nodule, which one should not neglect to test with a probe; on account of its softness the probe easily enters the skin, and thereby produces a small drop of blood.

From these initial nodules the various clinical forms of lupus vulgaris are developed, which will be now shortly considered in proportion to their practical interest. We follow the description of Jessner.

Lupus exfoliatus is produced by a thick collection of lupoid nodules, and presents a reddened, scaling, exfoliative surface, in which the brownish-red nodules can be more or less clearly recognized according to the amount of inflammatory hyperæmia of the tissue. In its further course cicatrization occurs in the

centre, from absorption of the nodules and connective tissue formation, while the disease advances at the periphery. The centre of the lupoid area then becomes slightly sunken, the redness disappears, and a white, superficial scar, which tends to contract, is gradually developed. The edges on the other hand, where the disease is advancing, always retain their early character. Its course is extremely chronic, the disease sometimes remaining stationary; ulceration is very rare.

Lupus hypertrophicus sive tumidus, as its name denotes, is marked by much formation of connective tissue, which gives it a tumour-like appearance. The separate lupoid nodules form projections of various sizes. The surface is thus uneven, of a red or brownish-red colour, and of a shiny or scaly appearance. The softness of the swelling is characteristic, and the recognition of this by means of a probe is important for diagnosis. The nodules as a rule occur in groups near each other; but they may join together to produce a confluent swelling. The course of this form of lupus is also extremely chronic, and it may remain for years with hardly any advance; on the other hand, the tendency to contraction and cicatrization is very slight.

When the surface of lupus hypertrophicus becomes horny and contains papillary thickenings, the rare form of lupus verrucosus sive papillaris is produced.

The third chief form is lupus exulcerans, beginning as quite small, individual ulcers as a complication of any of the other varieties of lupus, which maintain their own character as a rule for a long time. Lupoid ulcerations may be recognized by their soft, non-infiltrated edge, which is only rarely slightly undermined, and their florid red base, which bleeds easily, and is covered with exuberant granulations. The discharge of pus is slight, sometimes crusts form. The granulations may be covered at times with a thin layer of epidermis, but this is always only a transitory condition.

Lupoid ulcers spread extremely slowly at their edges; neighbouring ulcers may join. The advance as a rule only occurs at one part of the periphery. If cicatrization occurs at one side, while the ulcer spreads at another, the variety known as lupus serpiginosus is produced, the edges of which form segments of circles. The ulcers also may penetrate deeply, as is sometimes seen on the face, and lay bare the bones and cartilage, and may even entirely destroy the latter, as occurs most often with the nose.

Lupoid scars are, no matter from which form they result, generally white, soft and thin. Hypertrophic cicatrices are

rarely seen. Very often fresh nodules develop in the scars, leading to a relapse.

As serious complication of lupus may be mentioned, lupus elephantiasis, in which there is a hyperplasia of the connective tissue, that may give an appearance of true elephantiasis, especially in the lower part of the leg and the lobule of the ear; also lupus-carcinoma, which sometimes develops in the lupoid scars, and requires special attention.

The site of lupus vulgaris is in an overwhelming proportion of cases the face. The area round the nasal aperture is a particularly common site, but any other spot, e.g., the external ear and the eyelids, may be affected; the last spot is particularly dangerous, on account of extension of the disease to the conjunctiva. The point primarily affected is not usually the skin, but the mucous membrane of the nose, and extension of the disease to the mucosa of the upper air passages is no rarity. On the grounds of his own observations and an examination of the literature Dresch found that of 218 cases of lupus of the face, in which the nose was examined, lupoid changes in the nasal mucosa were constantly found. Also according to Gerber the primary affection in cases of lupus of the face was generally in the vestibule of the nose, and particularly above the anterior nasal angle. Gerber considers this point is of the greatest importance, and believes that the treatment of lupus can only be completely effective when it is combined with rhinological measures, a conclusion with which Wichmann, Senator, Holländer, and others, agree. Of other parts of the body the skin of the forearm, the hand, the lower part of the leg, and the foot is most often affected, and the disease may here take any of its various forms.

Lupus of the mucous membranes is not radically different from lupus of the skin, and is only affected by certain anatomical and physiological differences. The morphological forms of the disease are less sharply characterized and, as a rule, more difficult to distinguish. The typical initial stage consists of pale-red, soft nodules, generally slightly raised and showing through the mucosa. "That which in the skin would be a flat or slightly raised lupus, in the mucous membrane takes the form of a plaque formed of nodules closely packed together, which is often regularly thickened, pale-red in colour, of a round or irregular form, very soft and bleeding easily. Its colour may become very much darker from accidental irritation. These nodules may go through the same changes as in the skin; they may heal in the centre and spread at the periphery by continuity or by the forma-

tion of new nodules. They may become much thickened and then assume an opaque, whitish colour, or sclerosed and become quite firm; or they may grow out from the surface and specially in the nose form tumour-like masses. Most of all they easily become eroded and ulcerated. The erosions may become rapidly covered, but the covering is very easily removed. The ulcers, as in the skin, assume very various sizes, shapes and depth. Also they may spontaneously heal with more or less scarring and loss of substance" (Jadassohn).

Lupus is a disease of young people, its origin probably dates back to childhood; more rarely it commences in later life. The disease attacks by preference the poor. This may be accounted for by the neglect of the early stage, the disease being painless, and the general health practically not altered. Whether lupus is more often primary or secondary, and what are its relationships with tuberculosis of other organs, there are differences of opinion. In any case scrofulous glands are very frequently found with lupus; also there is no doubt that a considerable proportion of lupus cases die of pulmonary tuberculosis.

Diagnosis. The recognition of lupus is easy, so long as the characteristic lupus nodules are still visible.

How in cases of hyperæmia they may be brought out by pressure with a glass slide, and how their consistency may be tested with a probe, has already been described. The detection of the nodules is more difficult in the presence of marked hypertrophic swelling or ulceration. Here they must be searched for in the recent edge and at cicatrizing spots.

A confusion between exfoliative lupus and chronic eczema can be avoided if it is remembered that eczema is usually moist, itches much, never ulcerates and therefore leaves no scars. Psoriasis is distinguished by its position on the extensor surfaces of the limbs, by its smooth, silvery scales, and by never causing loss of substance of the skin. The distinction from lupus erythematoses can be made from the symptoms.

Lupus hypertrophicus sive tumidus can hardly be confused with any other skin disease; the characteristic softness of the lupoid growth has already been mentioned.

At first lupus exulcerans may be taken for a syphilitic ulcer, if lupus nodules cannot be found near the edge. The serpiginous form may be even more confusing. The soft edges and the base covered with florid, exuberant granulations are characteristic of lupoid ulcers, while syphilitic ulcers formed from gummatous infiltrations, frequently have waxy spots on edge and base, and on pressure are painful. If the ulceration affects the nose, as it

often does, it may be noted that the lupoid ulcers involve only the cartilage and nearly always stop at the bone, while syphilis has a preference for the bones, causing the sinking of the bridge and saddle-nose so characteristic of this disease. Further points for the differential diagnoses are naturally furnished by the other clinical symptoms. The histological examination of a piece of excised tissue or inoculation experiments on animals will also usually give useful information, but for the practitioner they are complicated and tedious in comparison with the more certain means of diagnosis—tuberculin. The cutaneous reaction in cases of lupus produces instead of the usual papule a large ill-defined swelling or lichenoid efflorescence at the site of inoculation, on account of the increased super-sensitiveness of the skin to tuberculin. With small early lupoid patches it has been recommended to make the inoculation on the diseased tissue itself, which produces an unmistakably strong reaction, with redness and exudation, followed by induration or necrosis. Other cutaneous tests are superfluous, and the conjunctival test useless, and contra-indicated if the lupus is situated near the eye. More characteristic and more generally useful is the effect of the subcutaneous test, which in early cases, as well as in the most advanced, gives a certain diagnosis in doubtful cases by the production of a typical focal reaction. For a full description of the tuberculin diagnosis in dermatology we may refer to our book on "Tuberculin in Diagnosis and Treatment."

Prognosis. The prognosis of lupus in early cases is good; but even here one is never safe from

relapses. The prospect of lupus of the skin is incomparably better than when the mucosa is affected, as in the latter case the disease is less accessible to treatment. With advanced disease the prospects of recovery are less bright, and depend upon the extent and depth of the disease, whether the mucous membrane is affected, the general condition, and the presence or absence of complications in other organs. Certainly the prognosis has distinctly improved during the last two decades owing to the advances of medical science. As in all other tubercular diseases, the prognosis is better the earlier the condition is recognized, and the more promptly radical measures are taken; so that early diagnosis and prophylaxis are of the greatest importance.

Treatment. So long as the treatment of lupus was purely medical the results remain unsatisfactory.

Reabsorbents, mercury and iodides were usually employed. The use of surgical measures, the modern advances in dermatology, and the dawn of the second tuberculin era have combined to

brighten the prospects of the treatment of lupus. Of the various treatments we will only describe those which are suitable for use by the general practitioner, while those which require the assistance of a specialist or demand complicated and costly apparatus will only be shortly touched upon.

Surgical treatment consists of excision of the diseased foci, to be followed by a plastic operation in cases in which union of the edges of the wound does not take place naturally. To prevent relapses it is absolutely necessary to operate in sound tissues. The focal tuberculin reaction is very useful here to bring out with certainty the demarcation between diseased and healthy tissue. Plastic measures consist of the use of flaps or of Thiersch's grafts, which permit the covering over of the largest gaps in the skin, and make possible extensive use of surgical treatment for lupus. There are a large number of reports of the permanency of the results; we may refer to the monograph of Lang and the comprehensive work of Spitzer and Jungmann, who have published the full results of 240 cases of lupus treated by operation. According to Lang it is necessary for excision that the diseased foci should be clearly marked out, and that it should be possible to cover the resulting defect of the skin with good cosmetic and functional results. The superficial extent and the depth of the disease are not of great importance in this connection; but almost all cases must be excluded from operative treatment in which the mucous membrane is much affected, as then radical measures are not possible; and also very anæmic, ill-nourished persons, who could not well support the shock and loss of blood. Lang has presented some remarkable cases of permanent recovery to the Commission on Lupus. The utility of the operative and plastic measures may be best shown by the following figures: Of 508 cases examined under control, 256, after a single operation, remained free from relapses up to 16 years.

When excision is no longer possible on account of the great extent of the disease Payr has recently successfully treated lupus of the trunk and extremities, by undermining the disease and raising it up in flaps from the subcutaneous tissue, whereby a deep effect is also produced. Strips of gauze soaked in balsam of Peru were drawn under the flaps and tied over them, the plugs being renewed about once a week. Recovery takes place after four to eight weeks, with good cosmetic results.

Good results can be obtained by destroying the lupoid nodules with the galvanic or Paquelin cautery under local anaesthesia, particularly when they are small. With larger areas of disease there will be considerable scar formation, which is

naturally an objection to this method for disease seated on visible parts of the body.

Scraping with the sharp spoon, either alone or combined with the previous method, has the advantage of easily removing the soft lipoid tissue, while the healthy and cicatricial areas offer more resistance. A radical removal of the diseased part, however, cannot be always guaranteed by these methods, so that an after-treatment with chemical agents is usually carried out.

Of the mask treatment recommended by Bæhr there have been very good reports; thus of late Knowsley-Sibley has described excellent results in properly selected cases. Caustics by themselves have given good results, especially in exfoliative and ulcerative lupus; while in lupus hypertrophicus a preliminary removal of the swelling is necessary. Of caustics the pyrogallie acid introduced by Jarisch is particularly esteemed. It has an elective destructive action on the lipoid tissue, leaving the healthy and cicatricial areas unaffected. An ointment of 5 to 20 per cent. pyrogallie acid is used, generally combined with an anæsthetic (orthoform or amesthesia), till all the diseased tissue is removed; for the after-treatment a weaker ointment of 2 to $\frac{1}{2}$ per cent. is used.

Of other caustics chief use is made of Joseph's 30 per cent. resorcin paste, Unna's green lupus ointment (acid salicyl., liq. antim. chlor., aa 2 parts, creosote, extr. cannab. indic. aa 4 parts, adip. lane 8 parts), or Unna's caustic potash paste. Neisser saw good results from Cosme's arsenic paste, also from ethylenediamine-cresol. Potassium permanganate in 2 to 10 per cent. solution is useful. Zinc chloride, lactic acid, carbolic acid, formalin, &c., are also used.

A marked advance in the treatment of lupus has been obtained by Finsen's method and by the Röntgen rays, though according to Lesser both methods have their limitations, especially in cases of very extensive disease, when the mucous membrane is involved, and when there is much scarring from previous unsuccessful treatment. Also both methods in contrast to the surgical treatment are tedious and costly.

Against the use of the Röntgen rays it has been objected that it is difficult to fix the duration of the treatment satisfactorily. When the superficial layers of the skin seem to have long reached their normal state, there are still to be found signs of reaction in the deeper tissues. Scholz and Gassmann have in cases of Röntgen dermatitis seen injuries of the cutaneous vessels, consisting of degeneration of the intima, atrophy of the muscular layer, telangiectasis and complete obliteration of the vessel with

degeneration of the skin and subcutaneous tissue. It is not possible to lay down accurate indications for the employment of the rays. Sometimes they fail altogether, sometimes their effect is good even in the most severe cases, which do not react to the Finsen treatment. They are best suited for ulcerations, and even more for much swollen, hypertrophic lupus of the skin and mucous membrane, and also as a preliminary for the use of the Finsen light, or lastly in combination with other methods.

As to the best method for using the Röntgen treatment, and the quality and quantity of the rays that are to be employed, the views are divergent. The majority of those using the method now employ a milder system with soft or medium rays and careful observation of the exact doses by means of a reliable dosimeter, of which those of Sabouraud and Nouré are the most practical.

The results of the Finsen light treatment are the most brilliant, and at present are superior to those produced by the Röntgen rays. The cosmetic effects are particularly excellent. In contrast with the Röntgen reaction the Finsen reaction can according to all observers be more certainly estimated; also the most difficult cases can be treated with this method, there being scarcely any contra-indication. However, it also fails in deep-seated lupus, and in lupus of the mucous membranes, especially of the nose.

It remains to be mentioned that both radium and mesothorium have been used with success. The results have been improved since suitable apparatus has been constructed to apply the radium to the cavity of the nose, the mouth, &c.

A capsule constructed by Westphal, of Berlin, is most serviceable for the interior of the nose; for the mouth and throat the use of plates made from soft impressions by Claudius Ait, Sons and Co., of London, may be most recommended.

The Finsen light treatment has led to the introduction of a series of methods, based on the same principle of employing the ultra-violet light rays in a more simple form. Such are the dermatolamp, the iron-light, the arriad, and the quartz lamps, and the mercury light. The potency of these light apparatus in lupus is still uncertain, the quartz lamp recommended by Knemeyer seems to be useful.

Still other methods are scarification, needling, and electrolysis, which no doubt are very useful for small lupus nodules, and give good cosmetic results. Also the various forms of freezing by means of ethyl chloride or a mixture of ethyl- and methyl-chlorides, liquid air, and recently carbonic acid snow are capable of curing lupus.

The hot-air treatment of Holländer has, too, given good result, especially in extensive, superficial forms, and according to Neisser in those forms of disease in which the mucosa is also affected. The hot-air possesses the advantage that it destroys the diseased tissue, while healthy parts are left unaffected; it is not capable, however, of any deep effect.

A method which has given striking results is the diathermic treatment lately recommended by Nagelschmidt. A high frequency current is here employed, like that used in wireless telegraphy. The application can be measured and localized, so that it is capable of superficial or deep action. It causes a production of heat up to 70 to 80° C., which produces a coagulation of the tissues. The duration of the application varies according to the size of the diseased nodules from some seconds up to several minutes at the most. Generally one sitting is sufficient, it is rare for more to be required. The throwing off of the tissue takes place rapidly. This new treatment is suitable for all cases of lupus, and also for all other forms of tuberculosis of the skin and mucous membrane, including the deeper complications.

Recently Pfannenstill has brought about remarkable recoveries in severe cases of lupus of the skin and mucous membrane by the internal administration of iodide of sodium and the external application of ozone. These results have been confirmed by Strandberg in the Finsen Light Institute; the method has been still further simplified in cases of lupus of the nose by replacing the ozone by the local application of tampons soaked in hydrogen peroxide.

In addition to the local measures the general treatment of the whole organism is naturally very important. The following factors are all of importance: a healthy dwelling, good food, a life in the open air, attention to the skin, possibly salt baths or sea air, treatment of existing complications, especially the tubercular and scrofulous constitution, and medical treatment by cod-liver oil, iron, arsenic, iodide, &c.

To the general and other treatment of recent years tuberculin has been added, which we can hardly recommend too much to the practitioner for use in suitable cases, either alone or combined with other methods. Even in the first tuberculin era very rapid healing was seen. But afterwards, with the modern advances in the treatment of lupus, tuberculin was undeservedly by degrees dropped, until of recent years it has again been brought to the fore. We consider that tuberculin has special claims to be included in the treatment of lupus on account of its action on lupus of the mucous membrane (B. Frankel, Domsiepoint,

Lauschi, and others), where all other methods usually fail, and because lupus is often complicated with tuberculosis of the internal organs. In his report to the lupus section of the German Central Committee for combating tuberculosis, Wichmann states that tuberculin "though not a sovereign remedy, yet is a very valuable aid and often an indispensable factor in the treatment of lupus."

There are a series of tuberculins which have been used subcutaneously, especially the old tuberculin. A marked superiority of one preparation over the others has not been shown, though by several authors the effects of bovine tuberculins have been praised, the indications being drawn from the supposed bacterial aetiology of lupus. Thus Möller recommends bovine tuberculin, especially where the human preparation has failed. In small lupoid nodules Nagelschmidt, by the production of a *v.* Pirquet papule in the diseased tissue itself, has produced healing over an area of several millimetres. Still more potent for the destruction of tubercular tissue is tuberculin in combination with other methods. Thus according to Senger no other treatment of lupus is as good as injection of a 3 to 10 per cent. tuberculin ointment with vasinol, in combination with Röntgen rays. On the same principle Münch recommends the use of sun rays, to be followed by injection of 1 per cent. old tuberculin lanolin ointment. Wolters records excellent results from local applications of pyrogallie acid combined with tuberculin treatment; it seems that the tuberculin sets free the bacilli from the deeper parts, and the exudation carrying them to the surface, they can be destroyed by the pyrogallol.

To sum up, we can say that the extensive, deep, and complicated forms of lupus should be treated exclusively by none of these methods alone, but that a combination of several forms of treatment is best employed in severe cases. These views are in accord with findings of the Lupus Commission. It remains to be seen whether the new diathermic treatment will fulfil the great expectations that have been formed of it.

For an effective attack on lupus and other forms of tuberculosis of the skin we especially desire that the treatment, though resting on a broad basis, should be centralized. Only a few lupus sanatoriums would be sufficient, considering the number of cases of the disease, to start a strenuous campaign, as the public sanatoriums have done for pulmonary tuberculosis. Since lupus is almost exclusively a disease of the poor, State aid would be necessary. By the formation of central committees for attacking lupus we are on the way towards this goal.

B. The Tuberculides.

The tuberculides have hitherto been regarded as being produced either by the soluble toxins of the tubercle bacilli like the other toxic exanthemata, or by weakened or dead bacilli or their remains. Thus, for example, Klingmüller saw as a result of the injection of tuberculin preparations lupus-like changes appear, an evidence that the substances dissolved out of the bacilli, or the remains of the living cells, may be the cause of a specific tissue reaction. Also Ziehl was able with a dialysed tuberculin, which was free even from ultra-microscopic particles of bacilli, to evoke the same changes in the skin. Up to a little while ago tubercle bacilli could not be found in the diseased tissues. Quite recently more light has been thrown on the obscurity which surrounds the origin of this group of skin affections. The very careful observations of Ziehl on the causation of toxic skin conditions in tuberculosis have led to the conclusion that the tuberculides are probably a weakened variety of bacillary skin tuberculosis, in which the bacilli in the skin as a rule rapidly perish. We therefore come back to the old definition of Jadassohn of the tuberculides. According to the fundamental researches of Liebermeister tubercle bacilli may not only cause a typical histological tuberculosis, but may also produce chronic inflammatory changes alone; this is true not only for the nerves, veins, heart, and kidneys, but also for the skin. A recent theory of Lewandowsky's seeks to explain the genesis of tuberculosis of the skin in its various forms by the measure of immunity of the infected organism. Besides the number and virulence of the tubercle bacilli, the antibodies of the organism play an important part. A massive dose of tubercle bacilli with failure of antibody production leads to miliary tuberculosis of the skin, numerous bacilli with scanty formation of antibodies cause multiple hæmatogenous lupus, while scanty bacilli with copious antibodies produce tuberculides, with rapid destruction of the infecting bacilli. The tuberculides are therefore, according to Lewandowsky, to be considered as a form of true cutaneous tuberculosis. The bacillary nature of some of the tuberculides has been placed beyond doubt by recent work. Particularly useful for settling this important question have been the antiformin method of Uhlenhuth and Much's discovery of the granular form of tubercle bacillus. A complete explanation of all these debated questions may be expected shortly. Hitherto there have been very various views as to which of the forms of dermatitis appearing in tubercular patients are to be reckoned as tuberculides. According to Jadassohn the characteristic of tuberculides lies in the frequent combination of the following clinical

attributes; the individual nodules of disease run an extremely benign course, and have a marked tendency towards spontaneous involution; they are inclined to disseminate, forming more or less symmetrical affections covering extensive areas of the body; they appear in patches, and affect particularly persons with chronic tuberculosis of the glands, bones, or skin. The most important tuberculides which we shall describe are the following:—

- * (1) Erythema.
- (2) Acnitis and Folliculitis.
- (3) *Acne cachecticorum* sive *scrofulosorum*.
- (4) Erythema induratum.
- (5) Lupus pernio.
- (6) Lupus erythematoses.

There are still a series of diseases of the skin whose connection with the tuberculides is extremely doubtful; such are pityriasis rubra (Hebra), multiple benign sarcoids (Boeck), and angiokeratoma. It will not be necessary to describe those conditions.

1. ERYTHEMA.

Anatomical Changes and Symptoms.

Many authors have observed erythema in cases of chronic lung tuberculosis, lupus, and more rarely tuberculosis of the bones and glands; that appearing after a tuberculin injection forms large, sharply defined, red areas, which on account of their transitory character have received but little attention. This skin affection is considered to be a tuberculide in its widest sense. It is produced by a tubercular toxin, just as the lichen eruption which may appear after a tuberculin injection. That these exanthemata, like all tuberculides, are closely associated with tuberculosis, is shown by the fact that they are never produced in non-tubercular persons by injections of tuberculin. It is obviously the result of a supersensitiveness of the skin of tubercular persons, our comprehension of the nature of which has been materially increased by the study of the local tuberculin reaction.

Diagnosis, Prognosis, and Treatment.

The erythema is easy to recognize, and would be probably more often diagnosed if more attention was paid to these forms of skin affection. Being a harmless erythema treatment is unnecessary.

2. ACNITIS AND FOLLICULIS.

Anatomical Changes and Symptoms.

Acnitis and folliculis described by Karkhemy and considered by him to be two different forms, have lately on account of the similarity of the pathological processes been thought to be a single disease, and included in the group of tuberculides as papulo-necrotic tuberculides (Jadassohn) or dermatitis nodularis necrotica (Török). The necrotic processes develop partly in the upper layer of the subcutaneous tissue or the deeper part of the cutis, and partly in the superficial layers of the latter. The superficial changes in the skin consist of slight, raised, pale-red infiltrations of the size of a hemp-seed, which become hyperæmic, increase in size, and necrose in the centre. In the middle can now be seen a greenish pustule of the size of a pin's head, which after discharging or drying up forms a dimple-like ulcer, and becomes covered with an adherent crust. An allied form is the papular or papulo-squamous tuberculide of infants described by Hamburger, which, though superficial and small, necroses in the centre and cicatrizes without tendency to ulceration, and is characteristic of tuberculosis of infants. Hamburger and Laineier were able in these tuberculides quite regularly to discover tubercle bacilli, which produced typical tuberculosis on guinea-pigs. Over the deeper-lying, hard, indolent nodules, which form extremely slowly, the skin is at first unaffected, and movable. Gradually the nodule becomes adherent to the cutis, and raises the epidermis, which becomes red. If it is not reabsorbed, after about fourteen days in the centre the first signs of necrosis appear as described above; the hyperæmia is commonly more intense, and the dimpled ulcer rather deeper. The crust in both forms remains about fourteen days, in which time the inflammation has subsided and cicatrization advances. When the crust falls off a sharply defined, round scar is seen of the size of the nodule; it is at first red, later pigmented, and lastly white and smooth.

The nodules are usually scattered, but those that are superficial are more often in groups than the deep ones, and they therefore have a greater tendency to become confluent. If this occurs thick infiltrations are found, with the same characters as the separate nodules. The symmetry of the condition is very characteristic. The deeper nodules are situated chiefly on the face, the ears, and the neck, while those that are superficial are met on the exterior surfaces of the extremities, especially on the elbow, hands, fingers, knee, foot, and toes.

The disease has a very chronic course of months or years. The nodules usually appear in batches with long intervals

between, often they can be seen lying together in all stages. Young and middle-aged people of both sexes are affected. Involvement of the hair-follicles or the sebaceous and sweat glands has not been proved; according to recent observations the disease spreads from the vessels, the condition thus being metastatic and embolic. The tubercular nature of a proportion of the cases is undoubted.

Diagnosis.

There is no difficulty in recognizing the disease. Certain groups of syphilides have a great resemblance, but the necrosis is in them more marked, and the characteristic symmetry is absent.

Prognosis and Treatment.

The prognosis is usually good, even in long-standing cases spontaneous healing may occur, though fresh relapses are possible. Treatment is generally useless. Help may be obtained from good food, open air, iron, arsenic, quinine, cod-liver oil, iodide of iron, and possibly also iodide of sodium.

3. ACNE CACHECTICORUM SIVE SCROFULOSORUM.

Anatomical Changes and Symptoms.

At first intensely red, later livid, nodules and acne-pustules of the size of a pin's head to a lentil develop in various parts of the body, particularly on the extensor surface of the legs and arms, the genital region, and lower part of the back, most often as a later development of lichen scrofulosorum, but also as a primary condition in cachectic and scrofulous persons. They are situated chiefly around a hair follicle, and have a bluish-red zone outside them. Beside them are usually residual white scars, which on pressure with a glass slide show no spots of pigment. Softening of the nodule and the formation of crateriform ulcers only occur occasionally; the remaining scars are then sharply cut, and have a violet and later a brownish colour.

Diagnosis.

Since acne cachecticorum is usually met with lichen scrofulosorum, nearly always in a cachectic and scrofulous person, the diagnosis is not difficult. It differs from acne vulgaris in the absence of comedones. The eruption may be confused with syphilis, but it is not so thick and ulcerates rarely. According to recent observations it reacts in a typical way to tuberculin, after which improvement, even healing, may occur.

Prognosis and Treatment.

The prognosis as regards the skin affection is good. For local treatment cod-liver oil and boric acid have been recommended. More important is the general treatment directed against the causal condition.

4. ERYTHEMA INDURATUM.

Anatomical Changes and Symptoms.

The affection of the skin described by Bazin as *erythème induré des scrofulaires* has a great resemblance to erythema nodosum, with which by many authors it has been incorrectly connected. There appear in the deeper part of the skin small, prominent, hard nodules, which are usually maliform and often arranged in circles; at first they are quite colourless, not tender on pressure, and cause no pain. Occasionally they may appear suddenly with pains. Their size is usually up to a walnut, and rarely much larger nodules have been observed. They are localized on the extremities, especially the shin; they may remain unaltered for years, and may disappear spontaneously. But generally they ulcerate. Gradually the infiltration softens, the surface becomes more swollen, and of a livid red colour. They break in the centre, discharge a sero-purulent fluid, and become covered with adherent scabs. The ulcers have a tendency to heal, but very slowly; but they may also become deeper and take on the appearance of scrofuloderma.

Erythema induratum attacks particularly young, weakened females, but men and older people are not exempt. It is often combined with other tubercular skin affections, and signs of scrofula. Its specific nature is not yet fully proved, but the local reaction to tuberculin and the typical tubercular histological structure of many cases point in this direction. But syphilitic and other diseases may have a share in its production. Very often it is due to an affection of the vessel, such as endarteritis or infarct, followed by necrosis.

Diagnosis.

The diagnosis is not difficult, and must be made from erythema nodosum, which, however, very rarely ulcerates. If the ulcers are deep scrofuloderma or an ulcerating gumma may be simulated.

Prognosis.

The disease is phlogistic, but even very chronic forms are not unfavourable, since they tend to recover as soon as the patient is put under good hygienic conditions.

Treatment.

The chief points are improvement of the general mode of life, good food, and attention to the skin. The affection being seated on the legs, rest in bed with the foot raised is required, with bandages and careful dressing if ulcers have formed. Thibierge and Weissenbach have lately cured five such cases by ambulant treatment with increasing doses of tuberculin, without other general measures. The results were confirmed by Jeannelme and Chosalier.

5. LUPUS PERNIO.

**Anatomical
Changes and
Symptoms.**

In close connection with erythema induratum stands lupus pernio, which by many, especially French dermatologists, is now included under lupus erythematoses, therefore we insert this description between those of the two allied conditions. The characteristic changes in the skin in this rare disease consist of bluish-red discoloration, not as a rule sharply defined, with a formation of firm nodules in the deeper layers of the cutis. On pressure with a glass slide the greater part of the discoloration disappears, leaving only greyish-brown spots, which at certain places may be more or less closely crowded together. After long periods telangiectasis may form. The nodular infiltrations by spreading at the periphery may become confluent, forming firm plaques; or they may involute spontaneously, leaving a scar-like atrophy. As a most important point in determining the origin of lupus pernio Jadassow has described the occurrence of typical lupus nodules on its surface or in its neighbourhood, wherefore he connects it with lupus vulgaris. Kreschik contests the tubercular nature of lupus pernio, since the cases observed by him gave no reaction to tuberculin.

The disease is situated specially on the face (nose, cheek, ear), hands and feet, more rarely on the arm, back, or buttocks. The course is very chronic. The regular exacerbations in winter call to mind the chilblains of phthisical patients, which many authors consider also to have a specific tubercular character; the assumption of a common disposition of tuberculosis and pernio as a consequence of bad nutrition and circulation is probably correct. Lupus pernio is often combined with other tubercular skin diseases and tuberculosis of other organs, especially the joints, the tendon-sheaths, and the bones.

**Diagnosis,
Prognosis and
Treatment.**

The disease is characteristic. The prognosis of the skin affection itself is not bad, but depends upon the complications. The treatment must be conducted on general lines, and requires no special description.

6. LUPUS ERYTHEMATODES.

**Anatomical
Changes and
Symptoms.**

The chronic form of lupus erythematoses is a much discussed skin affection, which has been termed by Volkmann lupus sclerificus, by Hebra sclerthoea congestiva, and by Unna alerythema centrifugum. These synonyms indi-

case both the prominent symptoms and the divergent views of dermatologists on the ætiology of the condition. Whether the various forms can be due to one uniform cause must be left an open question. The histological changes begin by an inflammation of the capillaries of the corium and papillæ, leading to cell infiltration, epithelioid and glandular changes, and circumscribed atrophy. Many observers have noted its connection with the sweat glands, which in the diffusely infiltrated skin can be seen to be enlarged, and to have their walls thickened. Recently Arndt has discovered by means of the antiformin method tubercle bacilli and Much's granules, so that now the long disputed tubercular nature has been proved for at least some of the cases.

The characteristic early form of the condition is a round, red spot, on which is an adherent, dry, scaly or fatty seborrhæic covering. On its under surface are one or more dimples, which correspond with enlarged openings of follicles. The process spreads centrifugally and very slowly, while in the centre a superficial, pale atrophy of the skin, which easily breaks down, appears without previous suppuration or ulceration. At one place several such spots may appear, and run together. Kaposi and most authors distinguish two chief varieties, the discoid and the disseminated or aggregated forms. The course is extremely slow and changeable, without the production of special symptoms. In severe cases deep, nodular infiltrations with dark coloration and thick crusts may form.

The favourite site, as in *lupus vulgaris*, is the face, particularly the bridge of the nose and neighbouring parts of the cheeks, where it often assumes the butterfly form that is met with in other skin diseases. Also the ears, the neighbourhood of the eyebrows and the forehead may be affected, but very rarely the eyelids, the lips and the mucous membrane of the mouth. After the face the neighbouring part of the head is most often involved, leading to persistent falling out of hair in the diseased areas. More rarely the extremities are affected, but if so it is usually the fingers and toes which suffer. The disease usually attacks young, weak, anæmic females, though older and stronger persons are not exempt.

Occasionally an acute form of *lupus erythematosus* has been observed, in which with high fever and marked general disturbance there is a dissemination of numerous inflammatory nodules, especially over the face; it may even end in death.

Diagnosis.

Typical cases are easy to recognize, and an early form should always be sought for. In other cases the condition is not clear. The differential diagnosis

must be first made from lupus exfoliatus. However, in the stage of the latter which it most resembles, the characteristic lupoid nodules can hardly be missed. Also the fatty, seborrhoeic covering is quite absent, whilst ulceration or deep scars are in favour of lupus. The covering in seborrhoeic eczema is not continuous, and does not adhere so fast to the skin; this condition is not so sharply defined and leaves no scars. The butterfly form may be confused with acne rosacea, which, however, forms no seborrhoeic crusts, causes no scars, and is usually accompanied with acne pustules. Papular syphilides may be distinguished by their copper colour, the firmer infiltration, the more rapid course and the absence of seborrhoeic crusts.

Prognosis.

The prognosis of lupus erythematoses in regard to healing is difficult to make in individual cases. A treatment, which may be most successful in one case, may fail in another. On the other hand, even severe cases may recover spontaneously. The course of the disease is so changeable and unexpected that with all methods of treatment rapid relapses can never be guarded against. Chronic lupus erythematoses has never been observed to affect the general health.

Treatment.

The best treatment is a combination of the internal administration of quinine, if possible in large doses of 15 to 30 gr. a day, with daily local applications of tincture of iodine, till irritation is produced (Hollander). If with the appearance of inflammation an advance in the disease is seen, the iodine must be stopped. This principle applies to all methods of treatment. Good effects have also been ascribed to the internal use of phosphorus and arsenic, but they have not received general acceptance.

Energetic rubbing of the diseased areas twice a day with soap spirit has been beneficial; after drying a 10 per cent. mercurial or sulphur ointment may be applied, or the ointment may be used alone. Others do not employ ointments, and in conjunction with internal remedies in early cases use cold compresses of lead lotion, and weak ichthyol solutions; in chronic cases strong ichthyol solution is recommended.

As in lupus vulgaris, applications of hot air and the various freezing methods have given good results in lupus erythematoses. Lassar advises that the glowing Paquelin cautery should be passed up and down over the diseased area without resting anywhere. Hebra saw good results from frequent dabbling with equal parts of ether and alcohol. Also freezing twice a week with ethylchloride has sometimes produced a cure; according to the

recently published experience of the Bonn dermatological clinic the use of carbonic acid snow takes the first place of all methods, so that it should be applied to all fresh cases (Löhlberg).

The more powerful remedies, which succeed in many cases of lupus vulgaris, must not generally be used for lupus erythematoses; thus radical cauterization with pyrogallic acid and surgical treatment need hardly be considered. Scarification, which was formerly much used, seems to be now quite given up. The many forms of light treatment have usually failed, but lately good results have been described from the use of Finsen light and radium. Hitherto very few observations have been made as to the effects of tuberculin.

The general treatment must be adapted to the individual. Anæmic and nervous disturbances and other predisposing causes must be attended to. The existence of a tubercular infection is to be particularly looked for.

CHAPTER IX.

Tuberculosis of the Organs of Locomotion.

1. TUBERCULOSIS OF THE MUSCLES.

Anatomical Changes.

MUSCULAR tuberculosis is characterized by smooth or nodular tumours of the size of a pea to a hen's egg, which lie within the muscle sheath, and between the displaced muscle fibres, and consist of tissue in a more or less advanced state of necrosis, containing tubercle bacilli. There may be either typical epithelioid and giant cell tubercles between the muscle fibres, or, as in the form produced by secondary extension, there may be solely a firm infiltration, with thick walls and caseation in the centre. Abscesses in the muscles of the abdominal wall have been found to be tubercular by the discovery of tubercle bacilli. Jonsdœr found also in the intermuscular lymphatic glands of children with generalized tuberculosis specific changes with virulent bacilli, and tubercular foci, which escaped even very careful examination with the naked eye. On the other hand, the so-called "nodular tuberculosis of muscle affecting cattle" is according to recent researches either a form of pyobacillosis or of pseudo tuberculosis.

Symptoms and Course.

Tuberculosis of the muscles either does not show itself at all, or only by interference with function, e.g., by difficulty in walking when it is situated in the quadriceps. The thirty to forty cases in the literature show that the muscles in the lower extremity in young people are chiefly affected.

The primary development of tuberculosis in the muscles is hindered by the muscle juices and the lactic acid. The secondary form occurs by direct extension of the tubercular disease from a primary localization in bone or joint.

Diagnosis.

An exact division between tubercular nodules, tubercular abscesses and tubercular myositis is more theoretical than practically possible. Beyond the recognition of the already existing tuberculosis, for the diagnosis of extension into the muscle there are the movability of the tumour when the muscle is relaxed, and its fixation when the muscle is contracted, its spontaneous appearance in contrast with the intramuscular hæmatoma appearing after trauma, the spontaneous pain or tenderness on pressure, the situation below the fascia and the fact that the skin is unaltered and movable. The tubercular tumour of the abdominal muscles is painful, seldom larger than an egg, intimately connected with the abdominal wall, hard or fluctuating, does not move with respiration, and is fixed and seems to more or less diminish with contraction of the muscle. Syphilitic gumma can be recognized by the history and result of treatment. The distinction from lipoma, fibroma, neuroma, and sarcoma will usually be possible. The chief point is not to forget the possibility of the occurrence of this rare condition.

Prognosis.

The prognosis is good, though relapses are not rare. When there is also disease of the bones or joints this will govern the prognosis.

Treatment.

The treatment consists of complete excision of the diseased nodule. The muscular substance must not be spared. Injections of 10 per cent. iodoform in glycerine are not to be recommended. Also simple incision and scraping give no certain results. Massage is contra-indicated.

2. TUBERCULOSIS OF THE TENDON SHEATHS AND BURSÆ.

Anatomical Changes.

Three different anatomical forms of this variety of tuberculosis have been recognized. The first, hygroma, is characterized by the serous contents, in which, and also on the thickened fibrous capsule, the so-called melon-seed bodies are found. They are small, rounded, greyish-white, opaque, bodies of the size of a millet to a maize grain, which as a consequence of friction have been rubbed off the shaggy wall. The second form, the fungoid, presents diffuse, exuberant granulations, with thick masses of richly vascular connective tissue, the fluid being scanty and of a clear, turbid or hæmorrhagic character. By the supervention of caseation the tubercular abscess of the tendon sheath or bursa is formed. The third and rarest variety is marked by great forma-

tion of connective tissue with subsequent contraction. One form may change into another.

**Symptoms
and Course.**

The clinical symptoms are a feeling of deadness, dragging pains, weakness and limitation of movement of the affected part.

The disease usually affects people in the third decade, who are hard manual workers. It most often appears at the flexor surface of the wrist or in the prepatellar bursa. Like tuberculosis of the muscle, it is not rarely primary, but more commonly it is a secondary metastatic condition, due to a lowering of the resistance of the tissues on account of some injury. It usually runs a very chronic course; often the disease spreads into the tendons themselves, or into neighbouring tendon sheaths or joints. Or the skin may become red and thinned, and gradually broken, whereby ulceration and fistulae are produced. The extension into the tendons causes them to be thickened, adherent or even destroyed.

Diagnosis.

The diagnosis rests on the presence of an indolent, fluctuating or doughy swelling at the site of one of the tendon sheaths. If free melon-seed bodies are present crackling may be detected. The discovery of tuberculosis in another organ is important. The regional lymphatic glands are only exceptionally involved; fever is absent. The differential diagnosis must be made from sarcoma, which grows quickly and spreads from the bones, from fibroma, which does not fluctuate, and from gumma, which is usually situated on the extensor surfaces and yields to iodides. Tuberculin or an exploratory incision will settle the doubt.

Prognosis.

The prognosis is not unfavourable if timely measures are taken, and is even good, since permanent limitation of movement can be thus prevented.

Treatment.

The treatment of serous hygroma consists of puncture, injection of 10 per cent. iodoform-glycerine and passive congestion. If this does not produce a cure, or if melon-seed bodies are present, a free incision should be made, the melon-seed bodies removed, and phenol applied after Mencière's method. This consists of soaking all the affected parts with pure carbolic acid for one minute, neutralizing with alcohol, and then closing the tendon sheath and skin with suture. According to Wetterer tuberculosis of the tendon-sheath, even if it is accompanied by the formation of melon-seed bodies, reacts well to deep rays. The favourable action of the Röntgen-rays in these conditions when not deeply situated is due to their direct action on the tubercular granulation tissue, which is twice as sensi-

tive to the rays as normal skin, and can therefore be destroyed without cutaneous injury.

In the fungoid form radical removal of the diseased membrane, that is, excision of the affected tendon sheath, followed by treatment with glycerine of iodoform, is required. Since the functions of the tendons are often affected, in all cases quite early movements and massage are necessary.

Recently Bützner, Jochmann, and others have recommended trypsin, a 1 per cent. solution of which is injected to the amount of 1 c.c. twice a week into the affected part. The trypsin solution takes the place of the leucocytosis which is absent in tubercular processes; in consequence of the action of the ferment hyperæmia with cellular infiltration and proliferation occur, the tubercular foci are peptonized and absorbed, while the more resistant cells in the healthy tissue are unaffected. According to Klapp and Brüning trypsin holds tubercular suppuration in check, and is superior to all other methods in the treatment of tuberculosis of the tendon sheaths and bursa. The experience at the Kiel surgical clinic was not so good; hygroma and fungoid conditions of the tendon sheaths showed no tendency to recovery after trypsin injections; in fact in the case of the former condition they were followed by so much pain that the patients demanded an operation.

It is possible that these different results may be due to differences in the preparation. Bützner recommends as the most active, purest, and most durable preparation of trypsin that of Fauschöld, Bosc, and Farber, of New York.

From our own experience we can warmly recommend the trypsin treatment for these cases. It is easier to apply than the iodoform-glycerine method, the amount of each injection being so much smaller; it is followed by but little general or local reaction; toxic symptoms are absent; and it can be carried out as an ambulant treatment by the practitioner.

3. TUBERCULOSIS OF THE BONES AND JOINTS.

Tuberculosis of the bones and joints diminishes in frequency with advancing age; and both in children and adults it is quite rarely a primary disease. Even when this form of disease occurs in an active form in children or adults free from hereditary tendency, when no point of entrance of the bacilli can be found, it is generally not the first localization of tuberculosis in the body.

E. König found in 59 per cent. of the cases on *post-mortem* examination old tubercular foci in the lungs and glands, more

rarely in the urogenital tract, which were the source of severe or fatal tuberculosis of the bones or joints. But there still remains about 20 per cent. of the cases in which an autopsy does not reveal any old, primary nodules. Although not finding a tubercular focus in the dead body is not identical with freedom from tuberculosis, one cannot deny under some conditions the possibility of primary tuberculosis of the bones and joints, especially in children, in whom scrofulous eczema of the skin, the easy vulnerability of the tissues, and permeability of the normal mucous membrane to tubercle bacilli, afford frequent opportunities of infection.

With regard to the infecting agent recent observations have shown that in surgical tuberculosis, of which affections of the bones and joints are the most common, the bovine bacilli play a large part. Raw rightly draws attention to the marked difference in the course of pulmonary and surgical tuberculosis. The former is usually the only tubercular disease in the body, affects commonly young adults, and claims most victims between 30 and 40 years. The latter usually appears at several spots, affecting simultaneously the bones, joints, vertebrae, or glands, and occurs chiefly in infants and children. It appears, therefore, that there are two different forms of infection, which resemble each other to a considerable degree, one being due to bacilli of the human type and the other to bovine bacilli. Raw saw no surgical tuberculosis in Siam, where cow's milk is not drunk.

There is a fundamental difference between the articular tuberculosis of children and adults, in so far as in children it is usually the first manifestation of the disease, while in adults as a rule there is an already existing, obvious tuberculosis of some organ. In both cases the bacilli reach the bone or joint from the primary focus through the circulation, more rarely by way of the lymphatics. The hæmatogenous infection explains the occurrence of the disease in young persons without other obvious tubercular localization. For the same reason the formation of tubercle in bones is connected with the nutrient vessel, the bacilli in the blood lodging most readily in the vascular tissue of growing bones. Traumatism, pregnancy, the puerperium, acute infectious diseases in childhood, especially measles and whooping-cough, are predisposing causes.

To sum up, we may say that a primary tuberculosis of the bones and joints is possible at any age, but that the secondary form is considerably more common, both in tubercular adults and apparently healthy children. Whilst in the latter the primary focus usually lies latent in the bronchial glands, in adults it is usually in the lungs, and is manifest.

The best arrangement will be to describe the anatomical changes, symptoms, course, and diagnosis of tuberculosis of the bones separately from the joints, and then to consider the prognosis and treatment together.

**Anatomical
Changes in
Tuberculosis of
Bone.**

The tubercular foci in the bones appear in different forms.

Tubercular osteomyelitis of the phalanges nearly always occurs by itself in young individuals; it has also been called *spina ventrosa*.

Rarefying osteitis, or caries of the bone in its strict sense, includes the infection of the spongy bone near the joints. By rarefaction of the bony framework and growth of granulation tissue, a rounded or cylindrical defect is produced, in which lies a soft, crumbling sequestrum, embedded in granulations. If the disease advances it may break into a joint, or spread up the shaft and pass through the bone and periosteum (periosteal tuberculosis).

A tubercular wedge or infarct is formed if any artery in the bone is blocked by tubercular material. The infarct lies with its base towards the cartilaginous surface, and is yellow and hard; in consequence of circulatory disturbance it becomes loosened from its surroundings, and forms a yellow sequestrum, which is not rarefied, since the process occurs rapidly and acutely. From irritation by the sequestrum the surrounding bone becomes gradually broken down; the cavity grows larger, and the sequestrum is gradually dissolved, so that at last a large abscess without sequestrum remains.

To these must be added the so-called proliferative, progressive tuberculosis of bone, which rapidly spreads in the Haversian canals from the shaft towards the joints, and quickly caseates.

**Symptoms and
Course of
Tuberculosis of
Bone.**

At the commencement of the disease all local symptoms are often absent; if pains occur they are due to involvement of the neighbouring joint, the periosteum or the soft parts. When the periosteum is

affected a swelling rapidly forms, with tenderness on pressure and oedema of the skin. As the disease spreads in consequence of thickening of the affected bone there will be swelling, pains, especially in tuberculosis of the bone-marrow, and obvious disturbance of function, the last as a consequence of foci forming in the epiphyses near large joints, such as the knee and hip. External discharge and fistulae occur secondarily, or if not, a cold or congestion abscess forms, which reveals the state of affairs.

The general condition is usually but little affected, sometimes

not at all; weakness and tiredness are the earliest signs. The temperature is commonly perceptibly raised; after rupture of the abscess it falls, but if mixed infection occurs it becomes much higher. In most cases the disease runs a chronic course, but it is not uninfluenced by the progress of the primary disease.

Diagnosis of Tuberculosis of Bone.

The diagnosis is easy if it occurs in a superficial bone in a tubercular subject. There is more difficulty in the differential diagnosis of the primary form, and of those secondary cases in which the obvious disease is limited to the bone or bone-marrow.

Tuberculosis attacks particularly the short bones of the fingers and toes, the carpus and tarsus, the sternum, the ribs, the vertebrae, and lastly the epiphyses of the hollow bones, while the diaphyses and all the flat bones are rarely affected.

Tuberculosis of the phalanges of the fingers, the so-called *spina ventosa*, is characterized by a firm or elastic enlargement of the bone, by spontaneous discharge of a thin fluid, with caseous debris mixed with the pus, by fistulae with caseous base and undermined edge, and by passage of the probe through the bone into the medulla.

Tuberculosis of the long bones has a greater predilection for the epiphyses than other acute and chronic diseases. Acute infective osteomyelitis is also distinguished by its great painfulness, by the uniform swelling without fluctuation or inflammation of the soft parts, and by the great disturbance of function. Metastatic and embolic inflammatory affections of bone occur as a result of pyæmia, enteric, scarlet fever, measles, &c. Chronic non-tubercular osteitis, periostitis, and osteomyelitis either develop out of the acute form, or follow an acute infectious disease (scarlet fever, enteric, &c.) first as a latent, then as a chronic, affection, or are due to syphilis or actinomycosis.

A careful history and exact examination into the earliest symptoms will throw light on the subject. The presence of tuberculosis in another organ, and a focal reaction after a test tuberculin injection, indicate tuberculosis with certainty; while syphilitic antecedents, a positive Wassermann reaction, and the improvement under iodides indicate syphilis. Actinomycosis is rarer, and can be recognized by the sulphur yellow granules in the discharge, which is rather gelatinous and mucoid than purulent.

Some of the discharge containing granules is pressed between cover slip and slide, and in the unstained preparation the irregularly-shaped clumps of microbial threads with their stellate and club-shaped projections can be recognized.

Tuberculosis of the ribs and sternum forms a very slowly growing, soft, painless swelling on the thoracic wall, which soon gives fluctuation; sometimes pains appear later. Branching sinuses facilitate the diagnosis; a cold abscess makes it more difficult. Pain and pressure behind the sternum and breathlessness raise a suspicion of sub-sternal abscess. Empyrematous abscesses, which pass on through the intercostal space and fluctuate, are rare; they cause circumscribed dullness, below which is a resonant note, thus differing from empyemata.

Tubercular spondylitis, which attacks specially children, and is met most often in the dorsal part of the vertebral column, causes as early symptoms tiredness on walking, sometimes dragging or stabbing pains in the back and legs, loss of appetite, peevishness, and sometimes in the evening slight rises of temperature, without any alteration in the shape of the vertebrae. Gradually the patient begins to spare the vertebral column, and to guard it against movements; then pains on pressure or jarring appear. Wollauer recognizes as the first symptom of lumbar spondylitis sciatic pains. Later, in consequence of compression of the spinal cord, the legs become paralysed, and the bladder and rectum are often affected. In less acute cases these paraplegic symptoms develop very slowly or not at all, for severe pains may be the only signs of pressure. In the second stage one or more of the vertebral processes distinctly project, and a curvature is formed.

Cold abscesses are characteristic of spondylitis; in affections of the cervical vertebrae retropharyngeal or retrotracheal abscesses may form, and with disease of the lower thoracic or upper lumbar column psoas, iliac, dorsal or gluteal abscesses. Sometimes muscular contractions develop; for example, in the *gastrocnemius* muscle, producing flexion and internal rotation of the leg. With disease between the atlas and occiput nodding becomes impossible, and if between the atlas and axis turning the head to the side is affected. Spontaneous luxations and subluxations may also occur with spondylitis of the cervical vertebrae.

For the differential diagnosis it may be noted that arthritis and spondylitis deformans usually occur in elderly people, and that traumatic inflammation of the vertebrae most often is seen in men in the prime of life, and is not associated with suppuration and cold abscesses. Osteomyelitis is rare, and comes on acutely with high fever and localized pains. Syphilis in this position is extremely uncommon.

The value of the subcutaneous tuberculin test for the recognition of tubercular disease of the bones has been already mentioned. It has the advantage over *v. Pirquet's* method that the

focal reaction indicates the localization of the disease. Neither the propagation nor the generalization of tuberculosis is to be feared from the tuberculin reaction. In connection with v. Parquet's cutaneous reaction the experience of Wilms may be mentioned, that it is absent in cases of fungoid tuberculosis wherever it is situated, also that it may be negative in persons who are not yet cachectic. It may be noted that the relatively favourable form of bone tuberculosis gives a very intense reaction to tuberculin, a sign of the energetic response of the organism against the infection. Besides human tuberculin bovine preparations are also useful, a fact in support of the view that surgical tuberculosis is largely due to a bovine infection.

The tuberculin diagnosis should be followed as soon as possible by a Röntgen-ray photograph; examination with the screen is also very useful.

Anatomical Changes in Tuberculosis of the Joints.

The frequency of tuberculosis of the epiphyses is of importance in the production of disease of the joints. This condition by extension may break through the cartilage, or may loosen or destroy it entirely,

or may pass round it at the place of insertion of the capsule, and thus set up an intracapsular infection of the joint; this is the osteogenic form of tuberculosis of the joint. Tubercular disease in the bone may also by infection of the periarticular soft parts cause extracapsular disease; thus is produced a cold abscess, which may discharge externally, or break through into the joint. Thus we have a secondary osteogenic joint tuberculosis.

According to earlier views quite three-fourths of all cases of tuberculosis of joints were infected from the bone. But recently it has been generally denied that primary synovial joint tuberculosis is less frequent and important than the osteogenic form.

Synovial tuberculosis generally arises from bacilli which are brought by the blood-stream to the capsule of the joint, the irritation of the synovial mucous membrane leading to a sero-fibrinous exudation, which is particularly rich in coagulative substances. The fibrin settles on the walls of the joint, becomes organized, and furnishes fresh ground for the formation of tubercles. Tubercular granulations are thus produced, which lead to destructive action on the tissues of the cartilage and bone, to thickening of the synovial membrane, and to caseation and suppuration. According to the predominance of one or the other process any tubercular inflammation of the joint may form hydrops tuberculozus, or the milary, fungoid, or fibrous form of primary synovial tuberculosis.

The most common form is the fungoid, in which flabby, red granulations studded with tubercles develop in the synovium, and the serofibrinous effusion changes into caseous, granular pus. Fungoid joint, white swelling, tubercular suppuration of the joint, and cold abscess are different names for the same pathological condition.

The suppurative form occurs especially in the knee and hip, while the fibroid form, or *caries siccæ*, generally is met in the shoulders.

If the disease passes through the capsule of the joint, either periarticular inflammation, suppuration, or congestion is set up, as in tuberculosis of the bone.

Symptoms and Course of Tuberculosis of the Joints.

The early symptoms generally appear gradually, but the onset may be more or less acute. The first subjective symptom is pain on use of the joint; the earliest objective sign is a general swelling of the joint.

As the pain increases the patient places the joint in the position in which it is easiest; and as result of mechanical and reflex irritations contractions may appear. If the disease progresses the swelling, fixation, and pain increase, and suppuration, with high fever, fluctuation and localized tenderness, appears. Spontaneous luxation and cold abscesses make the disease more obvious, while a later stage is reached if the pus breaks through the skin and the disease becomes open. Secondary infection and long continued septic changes lead to amyloid degeneration of the kidney, liver and spleen. The general condition then usually changes considerably, the fever becomes less or greater, or may be entirely absent. Loss of appetite and diarrhœa augment the wasting of the already anæmic patient.

The course of the disease is slow, usually lasting several years. Children are most often affected.

Diagnosis of Tuberculosis of the Joints.

According to Billroth tuberculosis most often attacks the knee, after that the hip, the foot, the elbow, the hand, the shoulder, and the fingers.

The symptoms will differ according to the function and structure of the several joints; the following indications will be sufficient for the thoughtful practitioner.

When the knee is affected the first sign of swelling will be that the hollows round the patella are not so clear on the affected as on the sound side; the contours become gradually effaced with increasing swelling till the typical fusiform appearance is produced. In the early stage pressure or movement are required to

elicit pain. The swelling will feel firm or doughy according to the predominance of the disease in the ends of the bones or in the synovial membrane, and according to the amount of implication of the periarticular tissues. The signs in suppuration of the joint are the same as in hydrops tuberculosus, *viz.*, fluctuation with characteristic swelling and floating of the patella. As secondary results the following contractures may occur: (1) flexion with outward rotation; (2) abduction and genu valgum, according to whether the leg is rested or moved. Also luxation and subluxation backwards may appear, if the capsule is long distended with much fluid.

Tubercular disease of the hip can be divided into three stages, which nearly always occur more or less distinctly. Bodily discomfort, slight tiredness, loss of appetite, and slight evening rise of temperature usher in stage I, in which the patient limps slightly, has slight pains on standing and walking, in the knee, more rarely in the hip or loin, and shows limitation of movement of the hip-joint; typical in its regularity is also a dragging pain down the inner side of the thigh to the knee. In stage II the thigh becomes distinctly flexed, rotated outwards, and abducted; the thigh on an average being flexed to 135° , and the leg being apparently lengthened. Often a swelling or thickening of the joint can be detected, with tenderness or pain on pressing the trochanter, or on tapping the sole of the outstretched leg; also limitation of rotation, and pain on extension and rotation are characteristic. In stage III adduction, internal rotation, and more marked flexion, with an apparent shortening of the affected leg appear in consequence of changes in the joint, and atrophy of the muscles from disuse of the leg. The soft thickening of the capsule may give rise to pseudo fluctuation; and in the majority of the cases suppuration will occur, with perforation anteriorly (extensor abscess), or internally (adductor abscess); more rarely the abscess extends into the buttock, the perineum, or the pelvis. Obvious fluctuation or the formation of sinuses near the joint indicate the occurrence of purulent inflammation. Later a backward dislocation on to the ilium may occur, with a real shortening of the limb, on account of changes in the socket, destruction of the head of the femur, separation of the epiphysis or over-distension of the capsule. Abscess formation or separation of the epiphysis are to be feared if, after a painless period, fresh pains appear. With the Röntgen-rays the circumscribed atrophy of the bone on the affected side is very characteristic of tubercular cystitis.

Tuberculosis of the foot often attacks several joints of the

tarsus at the same time. The ankle joint is most often affected. With effusion the foot takes a position of plantar flexion, and the joint capsule bulges at four points, anteriorly in front of the inner and outer malleolus, and posteriorly on each side of the tendo Achillis. Pain and swelling indicate disease of the other joints. The most common form is the fungoid, more rare is the exudative followed by abscesses and sinuses.

In tuberculosis of the elbow joint, which is less often due to bone disease (head of the radius, olecranon, lower end of humerus) than in the other joints, the capacity of movement is gradually limited, especially pronation and supination. With pains, which are often severe, the joint swells, and becomes fixed at a right angle. The joint becomes spindle shaped, and the muscles atrophy. The surrounding tissues feel doughy, or soft and elastic; the skin is smooth and shining. On the dorsal surface on each side of the triceps tendon elongated swellings form, consisting of the swollen and infiltrated capsule. The swollen capsule is particularly obvious on the outer side between the olecranon and the head of the radius. It may either give a feeling of fluctuation (effusion) or a soft elastic sensation (granulations). The normal movement is often much limited; sometimes there is abnormal lateral movement from loosening of the ligaments. If sinuses form, they are usually behind. Tuberculosis of the elbow often follows injury in young people.

Chronic inflammatory affections of the joints of the hand are almost without exception tubercular, gonorrhoea is the only other cause. Swelling, abscesses, and sinuses form. From gradual softening of the ligaments the hand becomes abnormally movable on the forearm, both to the radial and ulnar sides, also subluxation may occur. On passive movement crepitations may be detected.

Tuberculosis of the shoulder joint is not common; in childhood it is even rare. It appears usually as the fibroid form, or *caries sicca*, very rarely as a white swelling. The roundness of the shoulder is lost. An axillary fixation with falling-in of the soft parts below the acromion is simulated. In contrast with a true dislocation the thickened head of the humerus can be felt beneath the acromion. The alterations in shape occur gradually.

Tuberculosis of the finger joints is very rare, it usually arises from a *spina ventosa*. Almost without exception it then takes the chronic synovial form, which finally leads to ankylosis. Sometimes disease of the finger joints leads to an affection of the tendon sheaths.

The differential diagnosis must be made from arthritis de-

formans in older persons, from traumatic joint inflammation, which is shown by the history, from osteomyelitic affections, which run an acute course with high fever and severe pains, from gonorrhoeal disease, which is usually bilateral and often very painful, from rheumatic and gouty joints, which can be recognized by the results of treatment, from metastatic inflammations due to enteric fever, small-pox, scarlet fever, influenza, toxæmia and pyæmia, and lastly from syphilitic joints.

For establishing the diagnosis there are also the Röntgen-ray examination, and the use of tuberculin, especially by subcutaneous injection, so long as it is not contra-indicated by fever, marasmus or severe joint pains. The focal reaction consists of swelling and increased pain; tubercular sinuses, if present, discharge more freely.

**Prognosis
of Tuberculosis
of Bones and
Joints.**

The prognosis of the disease either in bone or joint is the more favourable the smaller the tubercular focus at the commencement of treatment, and the better the general condition. But in all cases there is a danger of a return of the disease, even after many years, except in those cases in which a successful operation has radically removed the whole focus. In the secondary cases the prospects of recovery also depend on the state of the primary disease. Tuberculosis of bone or joint is much more serious, for example, with advanced renal tuberculosis than with early disease in the lungs or glands. With this is connected the better prognosis in young people; the disease in children is much more often localized and uncomplicated.

Under similar conditions the prognosis of tuberculosis of the bones is better than that of the joints. The recovery of the latter usually takes far longer; in purulent cases death from marasmus and amyloid disease is much commoner than in the fungoid. The prognosis is not the same for the different joints; it is worse in those which carry the most weight, and therefore disease in the hip and knee is the most unfavourable. Nevertheless, under suitable treatment 20 per cent. of cases of tubercular coxitis recover with a fully movable joint and perfect gait, and 50 per cent. of cases of tubercular inflammation of the knee result in ankylosis. Here the prognosis chiefly depends on whether the disease is open or closed; in the latter it is much worse on account of the danger of mixed infection in spite of every care.

Thanks to modern methods of treatment the statement of Billroth is no longer true, that patients with healed tuberculosis of the joints do not live to become old, and that of children cured

by operation only the minority reach puberty. But it still holds good that the gravity of tuberculosis of the bones and joints must not be underestimated.

Treatment of Tuberculosis of Bones and Joints.

In the treatment it must not be forgotten that the power of resistance of the whole organism against the infection is lowered. It must therefore be the first care of the practitioner to employ general hygienic treatment, with the maximum of fresh air and sunlight. To these measures may be added cod-liver oil or malt extract, according to the individuality of the patient. In no case must one be contented merely to order increase of the food; on the contrary, over-feeding, especially if associated with deficient mastication and digestion, is to be avoided. Particularly the amount of meat must be limited, and the vegetables and fruits increased. Sea-air, mountain climate, salt and sun baths with frictions may all be useful aids, but they are not necessary for adults, and by themselves they are ineffective.

With the general constitutional measures must be combined local treatment of the affected bone or joint, in order to obtain healing with the least disturbance of the function and movement of the part. This local treatment may be surgical or conservative.

The conservative method may be first considered. Rest and relief of pressure are necessary in all cases of tuberculosis of the joints or neighbouring bones, in order to diminish the pain on movement, and the injurious effects of direct pressure on the diseased part, and to prevent the shortening of muscles and ligaments and therefore the occurrence of flexion. In joint tuberculosis permanent extension, to separate the diseased joint surfaces and to promote the absorption of effusion, is useful. Whether these ends are attained by orthopaedic apparatus (Hessing's bandage) or plaster of Paris, or by permanent or removable extension apparatus, is not so important as that the apparatus should fit well, give relief and prevent movement.

The conservative treatment of the most frequently affected joints can be carried out as follows: In tubercular exostosis can be recommended the application of a long plaster of Paris case with an extension stirrup, reaching from the lower ribs to the ankle, by which strong extension can be produced. It is agreed that it is preferable to the short apparatus reaching to the knee of Dollinger. The leg is to be put up in a position as nearly straight as possible; and the straightening must take place with great care, in old hip cases in stages, if necessary after subtrochanteric osteotomy. When an abscess or sinus is present an opening may

be made in the plaster case, while after this is removed Hessing's bandage, or a light splint, is to be recommended. Tubercular disease of the knee may be treated either with a carefully fitted, removable splint, or by plaster of Paris, leaving the pelvis free and reaching to the ankle, a stirrup being added by which extension can be applied if the pains are severe. If the stirrup is not employed the foot must be fixed with the plaster bandages. The apparatus must be applied in the most extended position possible. Faulty positions must be corrected by degrees without using force; in old cases with marked subluxation extra-articular, supracondylar osteotomy will be necessary. For the after-treatment Hessing's apparatus will be useful. For the other tubercular joints the methods used must be modified according to the nature and position of the joint. Thus, if the foot is diseased, it must be fixed by plaster reaching from the knee to the toes, and possibly the apparatus may be strengthened by letting in a steel sole. For joint disease in the upper extremity extension may usually be omitted and the fixation procured by a splint. Rest of the vertebral column may be best procured by a plaster corset, embracing the pelvis, since the column partakes in every movement of the hips; if the disease is situated above the fifth cervical vertebra the head must be fixed.

As aids to the conservative treatment there are the congestive hyperæmia of Bier and the suction method of Klapp, which may be employed when the disease is so localized as to be suitable, or when cold abscesses or tubercular sinuses have formed. The congestion should be induced by means of an elastic bandage applied two to three times a day, in such a manner as to produce marked hyperæmia, without the peripheral part becoming cold and without the production of pains or paræsthesiæ. The length of the congestion periods has been lately considerably increased, and the bandage has also been employed through the night; an increase in the inflammation is thereby produced, which, like the use of tuberculin, leads to reabsorption, fibrous tissue growth and encapsulation. The congestion works the better the hotter the diseased area; it is therefore recommended to warm the affected part before the application of the bandage by means of alcohol compresses or hot-air baths. The diseased area must not be surrounded with bandages during the application of the treatment. The idea that this method favours the formation of abscesses appears not to be correct. Cold abscesses may be punctured or opened under aseptic precautions, but they must not be scraped with a sharp spoon; afterwards congestion is to be again used. If they are not scraped, mixed infection need not

be feared. Small cold abscesses may also be treated by suction with the cupping-glass. After preliminary disinfection with iodine tincture (the abscess is to be opened by a puncture with the scalpel), and the suction-glass applied at first every day, later once or twice a week. Tubercular fistulæ can also be treated with the suction-glass, without being scraped with a sharp spoon. It is only necessary to cover the skin round the abscess or fistula thickly with lanolin-vaseline before the use of the suction or bandage, in order to prevent it being macerated and infected by the pus. To obtain good results the suction treatment must, as a rule, be applied for a long time. According to Bier, the congestion method must not be used with iodoform injections.

The oldest and still most popular of local applications is the injection of 10 per cent. iodoform-glycerine into the tubercular foci. The iodoform and glycerine are first separately sterilized by heating to $100^{\circ}\text{C}.$, after cooling they are mixed in a sterile vessel, and every two to four weeks are injected in the amount of 2 to 10 c.c., according to the age of the patient and the size of the diseased focus or the joint; the latter is to be afterwards carefully moved and massaged. The effect of this, according to Heile, is to cause the leucocytes to collect and to form leucocytic ferment, and thereby to peptonize tubercular pus, so that it can be reabsorbed. Cold abscesses must be first treated by aspiration of the pus. After a time toxic symptoms, such as headache, sleeplessness, peevishness, hallucinations, nervous and gastrointestinal symptoms, albuminuria, hæmaturia, must be looked for. Recently iodoform as the iodoform bone stopping of Moresig-Moochhof has been more used for tubercular disease of the bones and joints. It is now agreed that this treatment considerably shortens the tedious process of healing, and that it avoids the formation of ugly, painful, deep scars reaching down and into the bone. The indications for and mode of employment of this method in individual cases must be left to the judgment of the surgeon.

According to the original directions the iodoform bone-stopping consists of 10 parts iodoform and 40 parts each of spermaceti and sesame oil. It must be sterilized with the following precautions: All three ingredients, which have been separately sterilized, are mixed in a sterile flask and heated in a water-bath to $30^{\circ}\text{C}.$ to which temperature they are exposed for fifteen minutes. When the flask is removed the contents will have become liquid, and may be mixed by prolonged shaking. It is most important that the mass should solidify while the shaking is producing a thorough emulsion of the iodoform. At ordinary room temperature the stopping becomes a firm, yellow mass, which before use must be melted in a temperature of $60^{\circ}\text{C}.$ The composition can be kept for a long time in a hermetically-sealed flask, and is ready for use in a few minutes. After being melted it must be well

shaken, and then poured into the prepared cavity. Tonic effects are only rarely observed, and then when large quantities of the stepping have been used.

Into small foci of bone the trypsin solution that has already been mentioned can be injected in a per cent. solution; in many cases it acts very much better than the iodoform-glycerine. Good results have been observed from its use in fistulae, into which it can be injected, in ulceration of the soft parts when it can be injected or applied on sterile gauze, and in abscesses, into which it can be introduced after previous aspiration of the contents. By means of trypsin even primary foci that are accompanied by erosion of the bone and very purulent sinuses may become healed, provided that they are accessible to the injections. Lexer, Sohler, Brüning, Schaeck and others consider that trypsin injections are contra-indicated in joint disease, which is producing severe pains, fever and rigors, such as only occur in inveterate cases (separation of joint cartilage). According to observations in the Berlin surgical clinic, on the other hand, even severe cases of suppurative joint disease with sinuses were healed by means of trypsin without other treatment, the destroyed cartilage being regenerated and the functions of the joint maintained. Therefore trypsin is not only serviceable in the conservative treatment of tubercular disease of the bones and joints, but also as an adjunct to radical measures; thus the use of trypsin in articular and para-articular abscesses may improve operation results. In the Berlin surgical clinic the injections of trypsin were combined with injections of 60 per cent. alcohol. This latter is particularly recommended for those cases in which a growth of thick and firm connective tissue is required, and in which exuberant granulations require to be reduced. To avoid pain, Klapp first injects a c.c. of $\frac{1}{2}$ per cent. solution of novocain before the alcohol injection, which when possible should be given daily at several spots in the peritubercular tissue, and lastly into the tubercular focus; by constantly choosing fresh spots for injection he produces a gradual diminution in the extent of the disease.

Some English authors have recommended in place of iodoform-glycerine a solution of iodoform 5, ether 10, galic acid and stearate 50, 2, olive oil 100 parts, with which they obtain healing in 95 to 98 per cent. of the cases.

Frank, W. Wolf, and others see in tincture of iodine an almost sovereign remedy for tuberculosis both of the bones and the soft parts, after evacuating the pus and removing the tubercular granulations with a sharp spoon, the whole wound is thoroughly wiped out with 20 per cent. tincture of iodine.

Delver and V. Winawer, in cases of closed tuberculosis of the limbs, joints, or soft parts with intact skin and without softening or abscess

formation, especially in early cases, inject liquid soap with an equal part of water or alcohol into the diseased tissue, generally to the amount of 2 to 3 c.c., quite slowly through a hollow needle or fine trocar, and then apply immobilizing bandages. If the injection produces fairly severe pains, and next day a strong local reaction, it is not repeated for 3 to 10 days. The liquid soap acts as an antiseptic, without destroying the vitality of the tissues.

Novarsol has also been recommended for open tuberculosis with suppuration; it is odorless, non-toxic, and has a strong deodorizing action, it diminishes the flow of pus, it dries up parasitic wounds and sinuses, and leads to the formation of new, more healthy granulations.

Instructions of 10 to 25 per cent. iodoform has been praised in tuberculosis of the joint without implication of the bone.

Carbenzyme, an aseptic carbohydrate ferment, is very useful as a powder for tubercular ulcerations of the soft parts, or injection as a 5 per cent. solution into tubercular fistulas, abscesses, or ganglions. Since after a subcutaneous injection of radicalcarbenzyme a death from tetanus infection has been seen, it seems that the choice of this preparation is forbidden. In the Berlin surgical clinic sterilized carbenzyme in doses of 25 grm. in sealed glass tubes has been employed.

Beck's injections of bismuth paste (bismuth subnit. 50, cer. alb. 5, paraffin 1, vasoline alb. 50 parts), which has such a marked effect in bringing out the ramifications of tubercular fistulous tracks in the Röntgen picture, has not become generally accepted as a therapeutic agent. It may, however, be used in sinuses of the soft parts, which run a straight course. In extensive fistulae connected with the bones or joints its results are distinctly bad. There is also a danger of bismuth or nitrite poisoning, the first of which is not removed by substituting the carbonate for the nitrate of bismuth.

Lastly, we may mention the conservative treatment of streptococcal dactylitis by means of pyrogalllic acid ointment, which has been carried out at the Hamburg Sea Hospital; the diseased part is bathed daily for half an hour in sea water, and then bandaged with pyrogalllic acid ointment, first 10 per cent., then 5 per cent., when the skin becomes irritated, and lastly 2 per cent. The treatment lasted three to four months; if fistula had formed a year or longer. The finger returned to its normal shape, and its movements were unaffected; its growth was not interfered with. Sometimes small sequestra were thrown off spontaneously; their early operative removal is always to be avoided.

To the medical treatment belongs also the specific action of tuberculin. Alone it does not produce a cure, but in combination with the methods which have been described, it is a most powerful adjuvant for two reasons. Firstly, tuberculin facilitates the healing of tubercular bones and joints through its specific action of producing local hyperæmia. Further, it has a curative action on the primary focus in the bronchial or mesenteric glands, which is not always obvious, but which is dangerous to the patient and therefore demands treatment. Kraemer considers that its use is necessary for healed cases of surgical tuberculosis in order to prevent relapses. This can be explained by the fact that after the recovery of the disease in the bone or joint the latent focus in

some other part of the body is rendered innocuous by tuberculin. Since what we call a predisposition towards tuberculosis or weak constitution is much more often actually a latent tuberculosis, the good effect of an after-treatment with tuberculin can be fully explained. The percentage of relapses in these cases, which is still high, will be considerably reduced by such a treatment. This standpoint has been lately taken by well-known surgeons, as Sonnenburg, Vulpius, and Wilms. The last named holds that it is the duty of the surgeon, even after a quite successful removal of a tubercular focus, to see if the organism gives a positive reaction to tuberculin, and if it does not, to give the patient a course of tuberculin, as a prophylactic measure against a relapse or a fresh infection with tubercle bacilli. Those surgeons who omit the use of tuberculin lose the assistance of a very effective remedy, more potent than iodoforn, congestion or such other means, and the results of which can only be compared with those obtained by Röntgen-ray treatment. Lastly, as to the selection of cases, Wilms considers that for the exudative form of tuberculosis, especially bone disease with fistulae or abscesses, the tuberculin treatment "is by no means necessary." But in the cases of fungoid tuberculosis, in which the cutaneous test is negative, or not markedly positive, the tuberculin treatment according to Wilms is "not only expedient, but absolutely necessary." Fungoid tuberculosis certainly runs a relatively favourable course, but has a special tendency to relapse, and these relapses Wilms has seen less often after treatment with Koch's old tuberculin. Other authors use the bacillary emulsion given by the same method as that generally employed for internal tuberculosis; Rosenbach has recently recommended his tuberculin, which is biochemically weakened with the trichophyton fungus. Lenzmann injects tuberculin with liquid paraffin into the tubercular focus, at the same time employing congestion, and has obtained very good results, especially in disease of the hands and feet.

On the Röntgen-ray treatment of bone and joint tuberculosis the experiences are so numerous and favourable that the use of penetrating rays can be fully recommended. Of its action we only know that on the one hand it increases the fermentative and autolytic processes in the tissues, and that on the other a marked fibrous contraction of the granulation tissue plays a part. The treatment is somewhat tedious, and requires to be learnt and practised, but gives very good results in disease of small bones and joints when the full action of the rays is possible. For larger bones it is more difficult, but it is by no means impossible to obtain recovery. Wilms prefers the use of deep Röntgen-rays

for disease of the finger, hand, elbow, shoulder, rib, foot, and ankle; scraping and resection are confined to disease which is not yet extensive. Lately Wilms has combined the Röntgen-ray and the tuberculin treatments. Iselin employs the deep rays particularly for disease of the hand and foot, also when the general condition is bad, and for fungoid joint disease of old people, while for children it is better not to employ it on account of the possibility of interfering with the growth.

Radium has also been used for surgical tuberculosis, especially for abscesses and fistulae. French authors have recommended the introduction of small silver tubes containing radium sulphate into the tubercular tissue as superior to the superficial application of plates which have been covered with radium salts.

Lastly, there is heliotherapy. Rollier has published extremely good results from exposure to the direct sun-rays at a high altitude (Leysin-sur-Aigle) in the surgical forms of tuberculosis, especially in fungoid disease. Even tubercular disease of the vertebrae and hip with fistulae recovered at Leysin with the action of the sun alone. Rollier's figures showed in 369 cases of surgical tuberculosis that 87 per cent. were healed, 13 per cent. improved. Bardenheuer has employed treatment with sun-rays at Cologne according to Rollier's method in ten cases of closed tuberculosis of the joints with good results. Particularly striking were the effects on fistulae following resection of joints; long-standing sinuses closed promptly. Jerusalem has in the Grimsteinstein sanatorium successfully treated twenty-four cases of surgical tuberculosis with the sun-rays; also in Vienna the results were good. There are thus sufficient grounds for including sunlight, even in our latitudes, among the measures suitable for the conservative treatment of tuberculosis of the bones and joints.

From the experience of orthopaedic measures in combination with general treatment, congestion, iodoform, trypsin, tuberculin, Röntgen and sun-rays, there can be small doubt that the conservative treatment is gaining ground, and that now surgical treatment is relegated to the last place.

Clearer indications are needed for the use of surgical treatment. The *brûlement forcé* of the French authors, which aims at correcting faulty ankylosis by brute force, has now disappeared from use, as it contravenes the motto "*quieta non movere*." Even in obsolete joint disease forcible movement may stir up encapsuled foci and lead to miliary tuberculosis.

The operations of arthrectomy, resection, exarticulation, or amputation are indicated if there is nothing more to be expected from conservative treatment. This is the case if severe general

disease (nephritis, amyloid disease) is also present, when postponement of the operation would entail great danger to the patient; and also in those local conditions in which the resistance of the organism falls, so that life is endangered. This is especially the case with neglected suppurating sinus due to hip disease with mixed infection, when hectic fever and necrosis of the bone is present, and desperate cases of suppurative disease of the knee. On the other hand, it need hardly be said that an operation must not be done on patients in extremis, or on those who have not the strength to support it.

Limbs, which after complete recovery from tubercular disease are left functionless, or partly so, may be submitted to surgical treatment, if it is certain that the sound parts are still capable of use. In paralysis from spondylitis tuberculosa, laminectomy, *i.e.*, the operative opening of the spinal canal by removal of the vertebral arches is indicated, provided that an exact localization of the disease is possible. The laminectomy may relieve the paralysis; and in many cases the spondylitis itself may be improved by scraping out the diseased foci in the vertebral bodies. There are 246 cases of laminectomy with 60 per cent. of permanently good results recorded.

Lastly, operative measures are indicated for circumscribed extracapsular and extra-articular disease, before it causes further damage by extension, provided that the tubercular focus can be thereby completely removed. But the indications must be sought in individual cases. For example, a young patient, who is living under favourable conditions of hygiene and diet, should be treated by conservative measures if the disease is in a less dangerous position, such as the hand, elbow, or foot. But if under the same conditions there is an isolated epiphyseal focus, especially if it is endangering the knee joint, an operation will be indicated, all the more so if the patient is an adult. The social conditions of the patient must also be considered in a certain degree. Thus resection of the hip joint may be called for in a poor patient to shorten the duration of treatment, in spite of the inferior functional results.

We have here given some outlines for the treatment of tuberculous of the bones and joints; but "the indications and technique will vary with the joint and with the form of disease" (König). Therein lie the advantages of special experience and individual judgment, so that the most suitable measures may be selected and combined for each individual case. To the general practitioner falls first the diagnosis, and next the carrying out of conservative treatment under the advice of the surgeon.

Prophylaxis.

The preventative measures against tuberculosis of the organs of locomotion may be summed up by saying that they consist of those which tend to the prevention of infection of children with tubercle bacilli, together with those means which may be employed for increasing the powers of the constitution in resisting infection. These ends will be especially favoured by a healthy parentage, and the avoidance of infection by food or diet in small children. Latent tuberculosis of older children must not be overlooked. Lastly in all cases, including adults, the best prophylaxis of secondary joint infections is the healing of all primary foci in lungs, glands, &c. In open surgical tuberculosis the same care must be taken in dealing with the discharge and soiled dressings as is taken with the sputum in cases of open pulmonary tuberculosis.

4. TUBERCULAR RHEUMATISM.**Anatomical
Changes.**

Poncet first stated, in the year 1896, that, besides tuberculosis of the joints, there was a form of "tubercular rheumatism," which was connected ætiologically with tuberculosis, but the symptoms of which were essentially the same as acute and chronic polyarthritis rheumatica. According to Poncet this tubercular rheumatism may be either due to the tubercle bacilli themselves or to their toxins. The cases of the first class are explained as differing from tuberculosis of the joints in that the bacilli are very scanty and weakened, so that they are no longer able to produce specific changes. This hypothesis seems plausible, since tuberculosis is not in absolutely every case limited to the formation of tubercles; but may take the form of simple inflammation of a serous, sclerotic, or hyperplastic variety. Likewise it is possible to recognize, besides the true tubercles, in the same lobe of the lung exudative and inflammatory processes, which are considered to be due to the action of the bacilli. In Kuttner's clinic in Breslau tubercle bacilli were discovered in the blood of a typical case of tubercular rheumatism, the case being afterwards confirmed by autopsy. These observations support the view of the bacillary origin of tubercular rheumatism, and explain at the same time its connection with milary tuberculosis.

On the pathological condition may be produced by a toxin produced by the tubercle bacilli and circulating in the blood, which by virtue of a special predisposition produces lesions in the joints, different from the changes produced by the bacilli themselves. But it seems to us that it is not yet proved that a

toxin can be formed in some tubercular focus in the body, such as in the lung, and can produce in some distant organ or joint purely inflammatory changes with leucocytic exudation and fibrin formation.

Pathologically acute and chronic tubercular rheumatism can be distinguished. In the acute form there are simple inflammatory changes with thickening and vascularization of the synovia and serous exudation. The exudation, which has a strong tendency to fibrin formation, usually forms in larger joints, and causes oedema of the periarticular tissue. Miliary granules, tubercles, and bacilli are absent, but inoculation of the material sometimes gives positive results.

Chronic tubercular rheumatism sometimes takes the form of atrophic, poly- or mono-arthritides, which leads to deformities, and sometimes to dislocations, or may assume a plastic form with hyperostosis, producing arthritis sicca, ossificans, or ankylosis. In either case the same pathological changes affect the cartilage, the bone, and the periphery of the joint, without showing at any place the specific changes of joint tuberculosis. Ankylosis seems to occur from the formation of ivory outgrowths which lock the bones together, and diminish the movement of the joint more and more till it is lost. Poncet explains ankylosis spondylitis as a tubercular rheumatism of the spine of widely spread nature; in our judgment there are not sufficient grounds for this view; though not a small percentage of patients suffering from stiffness of the vertebral column die of pulmonary tuberculosis, yet on *post-mortem* examination no inflammatory changes are found in the intervertebral joints such as Poncet supposed (E. Fraenkel).

Symptoms and Course.

Since in tubercular rheumatism neither macroscopic nor microscopic specific changes can be detected, its recognition depends upon the clinical symptoms. Poncet classifies tubercular rheumatism among the inflammatory forms of tuberculosis and distinguishes three varieties.

The arthralgias appear as vague, dragging pains, especially in the larger joints and the vertebral column, with pains on movement and pressure, which come and go spontaneously, pass from one joint to another, often affect several joints at the same time, and disappear, leaving no trace behind. The important points are the absence of all perceptible, objective symptoms, and the fugitive nature of the pains.

The acute and subacute forms of tubercular rheumatism usually appear clinically as acute rheumatic polyarthritides. Beginning with fever, pains, and effusion into the joints, it affects now

this, now that joint, and comes and goes with a strong tendency to relapse. It may disappear entirely, or remain localized in a certain joint and become chronic. In the latter case the general condition gradually deteriorates, and the signs of a latent tuberculosis (anæmia, wasting, weakness) appear, or tuberculosis becomes manifest in some organ. Acute tubercular rheumatism especially attacks people between 20 and 30 years. It appears also in children, and not rarely develops into typical joint tuberculosis. Secondary acute tubercular rheumatism is not altogether rare. It is noteworthy that an improvement in the tuberculosis is accompanied by an increase in the rheumatism. It is not uncommon for the onset of primary tubercular rheumatism to be so acute that the inflamed, red joints are extremely painful and quite motionless, and the general condition is like that at the onset of a severe infection or simulates miliary tuberculosis. Such cases usually end fatally, without the characteristic signs of acute or miliary tuberculosis being found at the autopsy.

Chronic tubercular rheumatism may appear at any age, but usually during the second half of life; it may be the relic of an acute attack, or may take a chronic form from the first. Dry fibrous and osseous processes lead to chronic deformities and ankyloses, especially in individuals already suffering from internal or external tuberculosis. Various transitional forms also occur. We may shortly mention the most important: (1) Chronic osteo-arthralgias, in which there are vague pains, without deformities in bones or joints; (2) chronic polyarthritis with deformities, in which there are attacks of pain and marked swelling and deformity of the joint, especially the hands and feet, and which is generally associated with a furtive visceral tuberculosis; (3) chronic polysynovitis, in which the bursæ and tendon sheaths are frequently also affected; (4) arthritis sacca of the aged, in which pains, crackling, and deformity appear during the course of a favourable fibroid tuberculosis; (5) ankylosing arthritis, which almost exclusively appears in persons with quite latent visceral tuberculosis, and in contrast to ordinary rheumatism leads to ossification and ankylosis. Damp, cold and traumatism are only concomitant causes for the ankylosing inflammation, which attacks one or more joints, sometimes slowly and furtively, but more often with fever, sweats, wasting, swelling, and pains. The mono-articular form affects particularly the hip. Patients at the age of puberty are specially attacked, though the disease may also appear later in life.

Apart from the purely articular changes, tubercular rheumatism may cause a series of rheumatic affections of other organs;

thus the heart, the serous membranes, the nerves, glands, urogenital system, skin, muscles, fasciæ, tendons, and subcutaneous tissue may be implicated. Poncet also ascribes abdominal pain without diarrhoea in tubercular cases to a toxic origin, and considers them as "an equivalent of tubercular rheumatism." Further, Poncet sees in the arthritic diathesis (arthritis) the effects of the tubercular toxin, and holds with Leriche that in each case of rheumatism it should first be considered whether it may not be tubercular. Likewise Barber states "that the patients presented themselves with rheumatism, but were found to be tubercular." In a German work in 1909 it was even asserted that urethral strictures were directly due to the action of the tubercular virus. Such fantastic views must be firmly discouraged.

The frequency of tubercular rheumatism depends upon the view taken of the disease. If the attitude is sufficiently critical inflammatory changes due to tubercular toxin will be certainly rare.

Diagnosis.

A well-founded diagnosis of tubercular rheumatism is not easy, but is rather very difficult and nearly always uncertain, since on the one hand the symptom complex does not differ from that of ordinary rheumatism, and on the other there are no certain pathognomonic signs of tubercular rheumatism.

The family antecedents and personal stigmata have some diagnostic value. If sweats are absent in acute cases, if primary angina does not occur, nor endocardiac signs in children, ordinary rheumatism will be less likely. French authors consider the course of the disease alone in tubercular cases to be characteristic; and that an articular rheumatism of a chronic nature, tending to relapse and leading to ankylosis, is generally of a tubercular origin. Still more difficult is the diagnosis in primary cases, where it would be of the most value. In general a suspicion may be raised of the tubercular ætiology of a case of rheumatism if the general state is much altered while the temperature is proportionately low, if the swelling of the joints lasts long and recovers slowly, if the inflammatory symptoms are slight with much swelling and little redness, and lastly, if the disease runs an atypical and unfavourable course, and is not influenced by salicylates. If the rheumatism occurs in a joint near a recent tubercular focus, its tubercular nature gains in probability.

Test tuberculin injections are very valuable, especially in cases of primary tubercular rheumatism. Excessive doses of tuberculin may produce in healthy people effusion into the joints

solely as a result of toxic action. But if quite small doses of tuberculin increase the inflammatory signs in a suspected joint, while the general reaction is absent or only slight, it may be concluded that the rheumatism is tubercular. We have repeatedly seen after minimal tuberculin injections symptoms produced quite promptly, which could only be considered as focal reactions due to tubercular rheumatism. Also v. Hippel and Menzer have made the same observation. Poncet and Leriche recommend the agglutination method according to Courtmont as the most certain and convenient reaction. But this is not correct, since the agglutination test is both more uncertain and has no local diagnostic value. The Röntgen-ray examination naturally fails here. On the other hand examination of fluid withdrawn from the joint for lymphocytosis, acid-fast bacilli, and Much's granules, and inoculation of it on guinea-pigs, have in many cases been decisive.

Cases of arthritis of toxic origin appearing during other infectious diseases (scarlet fever, puerperal fever, sepsis, syphilis, gonorrhoea) may be easily distinguished by the history and by clinical observations.

Prognosis.

The prognosis of tubercular rheumatism depends on the nature of the primary disease. When this is absent, or tends to heal, then the course of tubercular rheumatism is nearly always good. More doubtful is the prognosis in acute cases, and those becoming chronic, since they tend to the production of hyperplastic inflammatory changes. Still worse is the prognosis in arthritis, which is becoming ankylosed.

Treatment.

The patient with tubercular rheumatism must in the first case be treated on the general lines for tuberculosis. In acute cases the joint must have rest. The pains may be relieved by warm compresses, light chloroform frictions, turpentine vesicants, and especially Bœr's congestion, which usually acts promptly. Salicyl and its derivatives are as a rule useless. Poncet and others have warmly recommended cryogenin in doses of 3 to 22 gr. a day. In the chronic form contractions must be prevented by massage, and active and passive movements; at the same time mineral waters (Wiesbaden, Wildbad) both internally and as baths may be useful. Eckert saw in children good results from drinking and inhaling water giving radium emanations. But chief reliance must be placed on the combination of the general constitutional treatment with tuberculin, which latter by raising the powers of resistance to the toxin relieves the toxic symptoms and prevents

the relapses of tubercular rheumatism. In one case, which was complicated by severe tubercular scleritis, v. Hippel saw with tuberculin treatment a most marked result; Menzer in another case after two months of tuberculin combined with warm baths observed that almost all the joints regained their full power of movement.

Prophylaxis. Tubercular patients with a tendency to rheumatoid affections in the joints should, if their social conditions allow it, in the moist and cold seasons of the year move to a warm, dry climate.

CHAPTER X.

Tuberculosis of the Nervous System.

From the tubercular diseases of the nervous system the functional nerve changes, neuroses and psychoses in tubercular patients must be distinguished. While the tubercular diseases of the nervous system are characterized either by tubercular changes in the nervous tissue, or by chronic inflammatory alterations without histological tuberculosis, due to the action of tubercular toxin, on the other hand functional and psychical alterations of the central and peripheral nervous system occur in phthisical patients from the interference with the organic functions, the dyscrasia, marasmus, and cachexia reacting on the nervous system.

The question whether tuberculosis of the parents produces a predisposition to nervous affections in the children must remain open, so long as it is undetermined whether it is the disease itself or only the predisposition which is inherited. It seems to be accepted that in certain families tuberculosis and nervous disease alternate, that hysteria and tuberculosis often occur together, but that epileptics are particularly resistant to tuberculosis. Doubtless alcoholism plays a large part in the production of psychical symptoms in tuberculosis, since the alcoholic is both bodily, morally, and mentally weakened, is most prone to infection, and offers least resistance to it.

We will consider first the tubercular diseases of the peripheral and central nervous system.

I. TUBERCULAR NEURITIS.

Anatomical Changes and Symptoms.

If tubercular disease involves the nerve either directly or by pressure, the nerve fibres will undergo chronic inflammatory or atrophic changes. Thus the spread of inflammation from a tubercular lung or pleura may cause specific

intercostal neuralgia, caries of the ribs may set up a true pressure neuritis of the intercostal nerves, caries of the atlas or axis may produce occipital neuralgia, and tuberculosis of the axillary glands neuritis of the brachial plexus. Also infection may spread from the apex of a tubercular lung to the brachial plexus, and many cases of "rheumatism" are due to a semi- or bilateral plexus neuritis of brachial origin.

In the peripheral and cranial nerves tubercular neuritis like other forms may appear as either mono- or polyneuritis. Of the cranial nerves the auditory and optic are most frequently affected by tubercular neuritis. The pathological changes are not always the same. Either tuberculosis of the ear, eye or skull bones may directly involve the nerve trunks, or intracranial tuberculosis may cause inflammatory changes in the nerves, or metastatic tubercles may be found in the nerve substance. Also in the cranial nerves that form of tubercular neuritis has been observed which is due to degenerative changes in the nerve fibres as a consequence of the action of tubercular toxin. In these degenerations of a toxic nature, which chiefly occur in the last stages of phthisis, bacilli cannot be found in the affected nerve trunks, in contrast with the leprosy forms of neuritis. They are comparable with the forms of neuritis caused by alcohol and lead, or carcinomatous cachexia, and are due to atrophy and destruction of the nerve-sheath, which is followed later by injury to the axis cylinders.

The vagus and sympathetic do not escape. Infection of the vagus in pulmonary tuberculosis usually takes place through the tracheobronchial glands. The symptoms consist of slowing of the pulse and respiration, cough, hoarseness, spasm and paralysis of the larynx. Involvement of the sympathetic from apical lung tuberculosis leads to dilatation of the pupil on the same side, a symptom which can be brought out by Valsalva's experiment and is of some value for the early diagnosis of pulmonary tuberculosis. Also intestinal symptoms and unilateral sweating of the head may in tubercular patients be ascribed to toxic action on the sympathetic.

In the peripheral nerves, Pitres and Vaillard have distinguished latent, amyotrophic and hyperæsthetic tubercular neuritis, according to whether the symptoms are absent during life, are motor (spasm, paresis or paralysis), or sensory (pain, hyperæsthesia, paræsthesia). "Latent" tubercular neuritis has no practical importance. Also the "hyperæsthetic" form is not a weighty matter as long as pains are not produced, and neuritic pains in phthisical patients may occur without nerve changes.

On the other hand, the "amyotrophic" form or symmetrical polyneuritis is a highly characteristic, but relatively rare, tubercular affection of the peripheral nerves.

Diagnosis.

With tubercular neuritis of the cranial nerves there will be signs of irritation or loss of function, such as deafness and alteration of sight. If the peripheral nerves are affected alterations of sensation (hyperaesthesia) will first appear, then motor and trophic symptoms. Among the last are herpes zoster and gangrene of the extremities, which has been observed as a result of tubercular neuritis.

Tubercular polyneuritis produces the classical symptoms of multiple degenerative neuritis; peripheral paralysis, irritative sensory symptoms and motor ataxia. This is not surprising, since in most such cases the tuberculosis is complicated with other septic or toxic factors (alcohol, syphilis).

According to Cassirer tubercular neuritis usually begins with weakness of the peroneal muscles; in the labouring classes the small muscles of the hand are often affected. Very often the lower extremities are solely affected, and may become completely paraplegic; the splinters usually remain intact. The pains may be very severe or only slight. Paralyses sometimes develop quite painlessly. Sensation is in most cases altered, but sometimes only slightly. The tendon reflexes are absent or diminished; very rarely are they increased. Occasionally the facial, vagus or phrenic nerves are also involved, causing alterations in swallowing or breathing, or diaphragmatic paralysis. More common are vaso-motor, secretory or trophic symptoms, such as cyanosis of the hands, oedema, sweating or alterations in the nails. The earliest of the objective signs is the reaction of degeneration. Tubercular polyneuritis can thus be diagnosed, if in a tubercular subject motor paralysis leading to atrophy appear with alterations of sensation and reaction of degeneration.

In making the differential diagnosis it must be clear that the symptoms cannot be due to changes in the central nervous system; very distinct and constant tenderness on pressure over one or more nerve trunks is in favour of polyneuritis, and against a functional, irritative condition occurring in a tubercular subject. The decision whether the neuritis is due to tuberculosis is very difficult, since various aetiological factors may be combined, e.g., tuberculosis with alcoholism or malaria. In the last case the result of treatment with quinine may settle the question. In cases in which there is doubt as to the nature of the primary disease a tuberculin test may be decisive, and in that way may point to the probable cause of the nerve affection.

Prognosis.

Tubercular neuritis may, so long as it is confined to a single nerve or plexus, subside and disappear. Tubercular polymyositis is less favourable. Sometimes the progress of the disease may be arrested for years. Implication of the vagus or phrenic usually is rapidly fatal.

Treatment and Prophylaxis.

Where tubercular processes in bones, glands, &c., are causing injurious effects on neighbouring nerve trunks, surgical measures may be taken against the disease.

Tubercular neuritis in all severe and recent cases demands absolute rest in bed, plentiful and easily digestible diet and regulation of the bowels. Careful and attentive nursing is in such cases a necessity. Severe pains may be met with dry or moist heat, cold or alcoholic packs, analgesics with or without morphia, and the constant current. Antipyrin, salipyrin, phenacetin, aspirin, antifebrin, lactophenin, pyramidon, dionin, codein, &c., act better combined in frequent small doses than as large doses of a single preparation. Strychnine and arsenic may be used in combination with tuberculin, provided that the disease is not too widely spread. Arsenic preparations must not be ordered with the derivatives of creosote containing phosphorus, since with this combination toxic action on the peripheral nervous system has been seen. If the patient is strong and the disease at a standstill use may be made of diaphoretic processes, such as baths with active movements while in the bath, followed by massage, faradization, gymnastics and thermal baths.

The prophylaxis consists in the avoidance of certain injurious factors tending to the production of neuritic disease in tubercular patients; such are cachexia, chronic alcoholism, and chills and wetting of the body, especially the lower extremities.

2. TUBERCULOSIS OF THE SPINAL CORD.**Anatomical Changes and Symptoms.**

The spinal cord and its membranes may be affected by primary or secondary tuberculosis; but secondary infection is much the more common. Up to now there are seventy-four cases of primary tuberculosis of the spinal cord in the literature. According to their localization they can be divided into the intra- and extra-dural forms.

The more frequent occurrence of the extra-dural form, also known as pachymeningitis tuberculosa externa, is explained by the frequency of carious processes in the vertebrae. From here the disease spreads by way of the intervertebral foramina or by breaking through the periosteal covering into the epidural space.

The disease now extends both upwards and downwards, forming caseous masses, or abscesses lined with greyish-red granulation tissue, which compress the cord and the venous plexus in its sheath. The granulations may also grow through the dura, and spread on its inner surface. Compared with disease spreading from the vertebral primary tubercle formation on the outer surface of the dura is of very small importance. It generally covers a large surface of the dura without exerting much pressure on the cord or nerve roots; and this explains the rarity of spinal symptoms.

Of the forms of intra-dural tuberculosis those that appear within the substance of the cord are of less practical importance than extra-medullary conglomerate tubercle, though according to Schlesinger the former are the most common variety of tumour of the cord. This is due to the fact that intra-medullary tubercle, like other benign forms of tumour, in its early stages displaces the tissues of the cord without infiltrating them, and therefore first produces symptoms from compression and softening when it reaches a considerable size.

True extra-medullary conglomerate tubercle, *i.e.*, a large nodule produced by the confluence of many miliary tubercles, generally grows out from the meninges, usually extends laterally and posteriorly in the direction of least resistance, and assumes an oval form. As it grows it compresses the cord, but rarely grows with its substance. This form of disease, compressing but not infiltrating the cord, is of importance from the therapeutic standpoint, since such tumours can be removed by blunt dissection, though at first sight they appear to penetrate into the cord.

The symptoms due to solitary and conglomerate tubercle begin with weakness, pains or paraesthesia in one extremity. At the commencement there is usually unilateral paresis, which in several weeks changes into motor and sensory paraplegia. Spasms are often absent, but irritative sensory symptoms rarely; later there may be total anaesthesia. All the symptoms are inconstant, and sometimes so little marked that it can only be said that there is some lesion compressing the cord at a certain spot.

Tubercular myelitis as an individual toxic disease is rare; it occurs as a rule in tubercular patients with constant, hectic fever, who are already suffering from multiple peripheral neuritis, and causes paresis, atrophy and oedema. More common is the tubercular myelitis due to inflammation or softening of the cord as a direct result of tubercular spondylitis. The cord usually attacks one, more rarely several vertebrae, and produces a growth

of fungoid granulations, with caseation and suppuration in the body of the vertebrae. When this becomes softened, it is dislocated from the pressure of the neighbouring vertebrae, and Pott's curvature is produced. Rapidly produced dislocation and narrowing of the canal lead to compression symptoms and to compression myelitis; the changes in the compressed cord usually here consist of congestion and oedema, rarely of specific tubercular disease. Deviation of the line of vertebrae is by no means always the cause of the compression; quite as often it is produced by an exuberant growth of tubercular granulation tissue, or by the cicatricial contraction of the same.

The symptoms consist of constant pain on pressure over the affected part, and of irritation of the sensory nerves, which, according to the position of the disease, may cause girdle pain or neuralgia in the arms or legs on one or both sides. More severe compression causes paraplegia; if the pains also persist we have the condition known as paraplegia dolorosa. Compression of a high grade leads to anaesthesia. Alterations in the skin, the tendon reflexes, the bladder and the rectum then appear.

Like the spinal cord, the medulla oblongata may be affected in disease of the occipital bone or first cervical vertebra.

Diagnosis.

The diagnosis of tuberculosis of the spinal cord may be made without difficulty when it is a secondary affection and accompanied by obvious vertebral caries. Considerably more difficult is the recognition of solitary and conglomerate tubercle, especially of the primary intra-medullary form; in the latter case not even a topical diagnosis may be possible, and it can be understood that of sixty-four cases of tuberculosis of the spinal cord, which were described up to the year 1906, only eight were correctly diagnosed during life. If the intra- and extra-dural nodules reach a certain size, they will produce meningitic or myelitic symptoms. The compression symptoms are the same as those produced by true tumours and non-tubercular diseases of the cord. It need here only be said that there are certain clinical symptoms which are very important for deciding the question whether conglomerate tubercle develops primarily within the cord, or whether it is growing from the meninges and merely compressing the cord. Early symptoms connected with the nerve-roots, hyperaesthesia in certain root areas on one side, and later the typical picture of Brown-Séquard's paralysis are indicative of disease commencing outside the cord and gradually compressing it.

Conglomerate tubercle must be differentiated specially from gumma. The distinction between the two may be very difficult

even on microscopical examination, and both may be clinically identical with true tumours. In such cases careful attention must be paid to the anamnesis, and general examination may lead to the detection of a primary tumour elsewhere, other tubercular disease, syphilitic manifestations, or echinococcal cysts, &c.

Prognosis.

Primary solitary and conglomerate tubercle of the spinal cord and tubercular myelitis have a bad prognosis. Better is that of tubercular compression myelitis, since ossification and recovery of vertebral caries is possible, and this is usually accompanied by improvement or arrest of the spinal symptoms. Also extra-medullary conglomerate tubercle, even if it is producing severe compression of the cord, is not absolutely unfavourable, since it can be removed without damage to the substance of the cord.

Treatment.

The treatment must be first of all general, with continued rest, and in cases of tubercular compression myelitis a prolonged period of lying on the back. Great care will be needed to prevent bed-sores, cystitis, &c.

Spinal disease secondary to vertebral caries must be treated on conservative lines with extension as long as one can hope by immobilizing the diseased bones to arrest the disease. Stationary conditions can be treated with orthopaedic apparatus and sea and salt baths. Drugs are useless, and surgical measures are only indicated if sequestra or abscesses can be diagnosed.

Progressive compression demands an operation, whereby not too small an extent of the vertebral canal is opened. If this shows that intra- or extra-medullary conglomerate tubercle is the cause of the compression, it must be removed in order to save life. This is not usually difficult, since the mass can usually be cleanly removed by blunt dissection.

3. TUBERCULOSIS OF THE BRAIN.

**Anatomical
Changes.**

Tuberculosis of the brain appears as greyish-yellow, caseous nodules, of a rounded or irregular shape, which affect particularly the deeper parts, especially the crus, the pons, and the cerebellum, and after them the cerebral hemispheres and region round the corpora quadrigemina. By the confluence of neighbouring small nodules conglomerate tubercles of the size of a walnut to a hen's egg are produced, which on section are either uniformly caseous, or are divided into separate crumbly tubercular masses; calcification is rare. The smaller tubercles are not rarely encapsuled, while the larger are more diffuse and

embedded in the white substance of the brain, and may give rise to diffuse caseous changes of entire brain areas. Solitary tubercle is relatively rare; it reaches the size of a pea to a cherry, not often of a hen's egg. Reutz has seen one as large as a billiard ball in the left parietal lobe of a patient, aged 40, in whom the autopsy also revealed old, healed apical tuberculosis, tuberculosis of the right kidney and the left adrenal, and miliary tuberculosis of the peritoneum covering the kidney. Tubercles of the brain are usually multiple; there may be a dozen or more scattered in different parts of the organ.

Tubercular abscess of the brain is a very rare affection; it appears in otherwise healthy persons and in those already tubercular; in the pus and in the abscess walls large numbers of bacilli can be found; usually it is complicated with tubercular meningitis.

Symptoms and Course.

The clinical symptoms are those of other brain tumours. Pains in the head and unilateral convulsions are the most common, while those due to increase of intracranial pressure (vertigo, slowing of the pulse, vomiting, optic neuritis) are often absent owing to the small size of the tubercular nodule. If obliterative arteritis occurs in the foci, areas of white softening appear in the brain substance. The symptoms thereby produced will depend upon the position of the softening; they are generally paralysis, usually unilateral, with epileptiform convulsions (cerebral cortex), hemiplegia with crossed facial paralysis (pons), and staggering gait and vertigo (cerebellum).

Tuberculosis of the brain most often attacks children, especially those in the first year of life; solitary tubercle has even been found in children a few weeks old. According to many authorities tubercle is the most common form of brain tumour, it takes the third place in adults and the first in children.

The latency of the condition is to be noticed. Even extensive cerebral tubercle may be completely latent during life and be first found on *post-mortem* examination. Also tubercles in one hemisphere may produce symptoms, while those in the other may not. Also the duration of the disease may be very variable; the period between the appearance of the first symptom and death may be measured by days or years. Acute cases not rarely end in tubercular meningitis, chronic ones in chronic hydrocephalus.

Diagnosis.

The diagnosis rests on a careful history and the recognition of a characteristic group of symptoms, of which the most important are signs of scrofula or tuberculosis of the lungs, glands or joints, epileptic attacks

followed by hemiplegia, gradual appearance of hemiparesis with tremor or contraction in one or both extremities, slowing of the pulse, rise of pressure in the spinal canal, strabismus, partial contractures, severe headache, frequent vomiting, mental changes and auditory hallucinations.

The differential diagnosis must be made from glioma, sarcoma, carcinoma, psammoma, cysts, and gummata. Since test tuberculin injections are contra-indicated in cerebral cases, one is limited to the cutaneous test and the search for other tubercular foci in the body.

Prognosis.

On account of the possibility of spontaneous healing by encapsulation or calcification the prognosis, especially in solitary tubercles, is not absolutely bad. The possibility of operative removal must also be considered in forming the prognosis. The case only becomes hopeless if signs of meningitis appear.

Treatment.

If syphilis cannot with certainty be excluded the treatment should begin with a trial of iodides. At the same time strengthening measures are indicated. Puncture of the brain or spinal cord are not to be neglected, since they have improved the results of operative treatment. Oppenheim was already, in 1902, able to collect thirty cases operated on with good results. But on the whole the conditions for operative interference are not so good as in spinal tuberculosis. The frequent multiplicity of brain tubercles, their usual situation in parts of the brain little accessible to surgical measures, the frequency of tubercular meningitis as a complication, and lastly the tendency to implication of the surrounding parts of the brain limit the opportunities of surgery, and frequently compel a mere symptomatic treatment. Against severe pains in the head may be recommended ice-bags, bleeding, migranin, antipyrin, phenacetin, &c.; against convulsions sedatives and narcotics, such as bromides and morphia, and pantopon, or better, diosin, codein or heroin.

4. TUBERCULAR MENINGITIS.

Anatomical Changes.

Tubercular infection of the pia mater leads to the production of miliary tubercles, to hyperemia, inflammation, and cellular exudation. The further pathological changes are localized chiefly in the vessels of the pia mater, especially in the medium-sized arteries, in the adventitia of which typical tubercles form; in the media there are cellular infiltrations tending to necrosis, and the intima becomes raised by endothelial infiltration, whereby the

lumen of small arteries may be entirely blocked. Tubercular meningitis affects constantly the cerebral cortex; small hæmorrhages in the form of rings round vessels undergoing hyaline degeneration appear in it. Sometimes the elastic coat of the vessel becomes ruptured, when larger hæmorrhages occur. The base of the brain is more often and more severely affected than the convexity, hence the term basal meningitis. The area most affected is that between the chiasma and the medulla oblongata, reaching to the Sylvian fissure on both sides. The pia of the cord is frequently also affected, explaining the occasional spinal symptoms. Since there is usually serous effusion into the ventricles, the disease is also known as acute hydrocephalus.

Symptoms and Course. Primary meningeal tuberculosis is extremely rare; it is still undecided if it may occur from the inhalation of tubercle bacilli

through the nasal mucous membrane—as a rule it is secondary to tuberculosis of the lung, the pleura, the bronchial, or mesenteric glands, the bones and joints, and the urogenital system, and not rarely to vertebral caries or solitary tubercle of the brain. Even calcified bronchial glands may be the starting point. The infection occurs by the lymphatics, the lymph-spaces in the nerves playing a part, or by the blood-stream. In the latter case the meningeal disease is part of general miliary tuberculosis. Acute infectious diseases, sexual development, traumatism and operations are predisposing causes. The disease occurs most often in children and young people; but it is not so rare in older persons as has been generally supposed.

In the symptomatology of tubercular meningitis in adults the following points may be remarked.

The prodromata consist generally of pains in the head and heaviness, more rarely of vomiting, sleeplessness, constipation, diarrhoea, and chills; also psychical depression, mysterious changes of character, and hysterical attacks not rarely are met with.

The transition to manifest meningitis usually occurs gradually, rarely suddenly. Then pains in the head, stupor, somnolence, incoherence sometimes reaching the grade of a psychosis, and delirium with picking at the bed-clothes appear. Groaning and sighing are very common, the hydrocephalic cry is rarer, trismus, vomiting, constipation, or diarrhoea are not constant. Almost constant symptoms are retention of urine and rigidity of the neck, so that these in combination with headache and incoherence are of pathognomonic importance.

There are many symptoms connected with the muscular and

nervous apparatus. Muscular rigidity appears more often than contractures; the patella reflex is usually increased, sometimes it cannot be elicited on account of muscular rigidity; there may be considerable differences between the right and left sides. Babin-ski's reflex is as a rule positive. Convulsions and tonic or clonic spasms are often seen in the face, either alone or in combination with irritative symptoms in the extremities. It is not unknown for adults to have epileptiform attacks. The paralytic symptoms in the face and extremities are often at first of a spastic, later of a flaccid nature. Aphasia is not rare, sometimes it is marked. Hyperaesthesia, rarely analgesia, may be present.

Eye symptoms often occur, such as differences in the size and reaction of the pupil, ptosis, and strabismus, usually convergent. Optic neuritis is not often found. Choroidal tubercles are more common, but are not looked for often enough, as they have great diagnostic value.

The temperature remains normal only exceptionally, it usually varies between 98.4° and 102° F., but may rise to 104° or over. Before death abnormally low collapse temperatures, which may be below 95° , are found. The pulse varies between 60 and 120; at the end it may reach 200. The respirations are between 20 and 40; Cheynes-Stokes' breathing is not seen in the majority of the cases.

The want of uniformity in the symptoms is well explained by the varying course of the disease, which has from the clinical point of view been divided into typical, atypical, rapid, protracted, localized, and other forms. In adults two chief forms can be distinguished. The acute variety usually complicates cases of pulmonary tuberculosis, who one day are found to have somnolence, delusion, or some local symptom, fall gradually into a comatose condition, and die in a few days. On the other hand, there is a distinctly chronic form which may last for months. The disease is then situated chiefly at the convexity of the brain, especially in the neighbourhood of the falx. The symptoms consist of partial Jacksonian epilepsy, paresis, contractures of certain groups of muscles, and aphasia.

With regard to the course of tubercular meningitis it may be noted that there are cases with some tendency towards spontaneous recovery. This is shown by the fact that some cases exhibit more acute phases separated by periods of remission (O. Ranke).

Diagnosis.

On account of the protean forms of the disease the diagnosis is often difficult and sometimes impossible. This is particularly so with older

patients, in whom the clinical features are indistinct and transient. An important indication in all cases is Kernig's sign; this consists of the impossibility with the patient in a sitting position of fully straightening the legs, the meningeal irritation having produced a cramp in the hamstring muscles. Lasègue's sign has also some practical importance; this consists of the impossibility in the recumbent patient of flexing the hip to a right angle with the knees fully extended. In general the following three stages of the disease can be recognized. After more or less obvious prodromata the stage of cerebral irritation begins with pains in head, stiffness of the neck, vomiting, somnolence, and delirium. Next follows the stage of cerebral pressure with stupor, slowing of the pulse, implication of the cranial nerves at the base of the brain, rigidity, or other changes in the extremities. The paralytic stage is the last, in which deep coma, disappearance of the contractures, increase in the pulse-rate, marked variations in the temperature, and Cheyne-Stokes breathing usher in the fatal termination.

In non-tubercular, purulent meningitis there are no tubercles to be found in the choroid, and no tubercle bacilli in the fluid removed by lumbar puncture. But neither of these signs occur with regularity in tubercular meningitis. Lumbar puncture only gives positive results if bacilli can be found; but it is to some extent indicative of tuberculosis if the fluid contains a distinct excess of leucocytes, if the amount of albumin is raised above .5 per thousand, and if there is distinct lowering of the freezing point.

For performing lumbar puncture a sterile needle 2 or 3 cm., or for children about 5 cm. long is required. The patient lies near the edge of the bed on the left side, with the knees drawn up on the abdomen; a distinct lumbar convexity with widening of the intervertebral spaces is thus produced. In meningitic children the puncture can also be made in the sitting position. The best point of entry is between the third and fourth lumbar vertebra; this is easy to find in thin people by counting the spinous processes. If this is not easy a horizontal line may be drawn between the upper limits of the ilium of the two sides, which will pass over the spine of the fourth lumbar vertebra, and above it the needle can be introduced. The spot is to be disinfected with tincture of iodine, and anaesthetized with a spray of ethyl chloride. In children the needle is introduced just under the spinous process in the middle line in a direction slanting slightly upwards. In stout adults it is better to introduce the needle 1 cm. to the right of the middle line, when the patient is lying on the left side, and to direct it slightly upwards and towards. The fluid is received into a sterile glass; the removal of about 5 to 7 cm. is sufficient; it is not necessary to measure the pressure. After withdrawal of the needle the puncture may be closed.

For examination of the fluid for tubercle bacilli, Engel recommends the following method: The fluid free from blood is to be put on ice for twenty-four hours, a delicate, cobweb-like clot then forms, which can be

best seen against a dark background. The fluid is poured into a flat dish, and some of the clot transferred to a well-cleaned cover-slip, and thoroughly spread out. The preparation is dried in the air, fixed and stained in the usual way. The cells and bacilli contained in the threads of the clot are easy to find.

The presence of lymphocytes in the fluid can be determined by staining with Löffler's methylene blue.

For the estimation of the albuminous contents of the fluid in place of the somewhat cumbersome method of Nissl-Eisbach that of Nonne and Apelt may be recommended, which consists of an examination for globulin. The fluid is mixed with an equal part of a saturated solution of ammonium sulphate, which normally in the cold gives no precipitate, but does so in organic diseases of the central nervous system on account of the pathological increase in the globulin content.

The diagnostic importance of pressure measurement is not great, but it may confirm the clinical evidence of increased pressure. The spinal fluid is normally under a pressure of about 125 mm. of water in the lying, or 140 mm. in the sitting position. If the former figure is raised to 200 or the latter to 300 or more it is indicative of meningitis.

The cutaneous test is permissible, but of doubtful value in adults; the subcutaneous test is contra-indicated.

Prognosis.

The prognosis is not absolutely hopeless, since the possibility of recovery has been anatomically proved. Of recent years clinical observations of cases of recovery have multiplied. Thus Freyhan, Henkel, Barth, Gross, Clusio and Alrami, Archangelsky, Rumpel, Hochstetter, Riebold, and H. Stark have seen undoubted cases of tubercular meningitis permanently recover after repeated lumbar puncture, and this is possible even in very severe cases.

Treatment.

The treatment consists first in the application of ice and cold compresses to the head and neck, and in prolonged warm baths. Alsounction of mercurial or iodoform (1 in 10) ointment has been recommended. In cases in which purulent infection cannot be excluded with certainty use may be made of intravenous injections of collargol (5 to 10 c.c. of a 2 to 8 per cent. solution) every twenty-four hours with inunction of Crede's silver ointment (15 to 45 gr. several times a day) into the skin of the back, which has been cleaned and rubbed with benzine, the part being after covered with flannel. By several authors the applications of Bier's bandage to the neck has been warmly recommended. In the stage of irritation narcotics can be hardly avoided, and in the paralytic stage inhalations of chloroform may be used to give relief, since recovery is no longer possible. Tuberculin is useless, and not without danger.

Lumbar puncture has a palliative value, since it lowers the raised intracranial pressure, and thus diminishes the mechanical

pressure effects in the medullary centres, and prevents degenerative encephalitis. The immediate results are improvement in the symptoms, with diminution or disappearance of the vertigo, delirium, headache, and rigidity of the neck. If done early one or two punctures will be enough, and as much fluid must be removed as to bring the pressure back to normal; in other cases it may have to be done every day or every other day. Richold saw recovery after twenty-four punctures. In any case frequent lumbar puncture according to the observations of Henkel, Archangelsky, Rumpel, and others and the experience of the Leipzig medical clinic has such a good effect on the symptoms that it should be generally employed. Lumbar puncture should be as much used by the practitioner as puncture of the serous cavities. The technique is the same as for the diagnostic lumbar puncture. The amount of fluid to be withdrawn depends upon the pressure it is under. In general not more should be taken than will leave an approximately normal pressure of 120 mm. in the lying, and 400 mm. in the sitting position.

5. FUNCTIONAL NERVOUS CHANGES IN TUBERCULAR PATIENTS.

Symptomatology. Functional changes in the peripheral nervous system in phthisical cases are brought about by the alteration in the plasma. Irritative symptoms are usually sensory and consist of hyperæsthesia and paræsthesia. Hyperæsthesia of the skin and muscles and paræsthesia often occur unilaterally over the affected lung. Hyperæsthesia may also appear as a reflex set up by tubercular disease of an internal organ through the sympathetic and vagus in certain definite zones and areas in the skin. In this way also may be explained spinalgia, fibrillary muscular contraction, and certain vasomotor effects, such as circumscribed redness of the skin of the cheeks, rapid changes of colour, dermatographia or urticaria factitia, and increased sweating.

Certain groups of nervous symptoms may also be caused by tubercular disease of certain organs. We may mention the occurrence of symptoms of exophthalmic goitre with tuberculosis of the thyroid, of tetany with tuberculosis of the accessory thyroids, and of the marked nerve symptoms with tubercular disease of the adrenals. The changeable nature of the body temperature of phthisical patients belongs to this group of symptoms. Köhler ascribes the close connection in phthisical cases between the temperature and mental states to an increased

irritability of the heat centres. Menstrual and premenstrual fever in tubercular women may also be a condition connected with the vasomotor nerves.

**Prognosis and
Treatment.**

The prognosis of functional alterations is good. The treatment consists of suggestive action on the skin by spirit frictions, painting with iodine and iodo-guaiacol-glycerine, vesication, faradization, and hot-air baths.

Also a general tonic and hardening treatment must be carried out, and at the same time psychical influence must be brought to bear on the patient.

6. NEUROSES AND PSYCHONEUROSES IN TUBERCULAR PATIENTS.

Symptomatology.

Owing to the frequency of both neurasthenia and tuberculosis a mere coincidence of the two diseases in one patient does not necessarily mean that they are in causal relationship. On the other hand there can be no doubt that even quite in the early stages of tuberculosis owing to the action of the disease on the central nervous system there is a condition of nervous irritability, which in cases of congenital or acquired nervous weakness may reach a grade of distinct neurasthenia. Besides the nervous irritability a marked feature of the disease is an increased reaction to impressions arising outside or within the organism.

The condition is of considerable practicable importance. Early tuberculosis may take the form of neurasthenia, and on the contrary purely neurasthenic symptoms, such as slight irritability and tiredness, lack of appetite, night sweats, and headache, may simulate pulmonary tuberculosis. As a matter of fact both diseases are taken for the other; the neurasthenic is sent to the sanatorium, and the tubercular patient passes as a neurasthenic. The views of sanatorium physicians as to the frequency of neurasthenia among the tubercular inmates vary considerably. According to Weygandt from 10 to 90 per cent. of the patients suffer from neurasthenic irritability, 50 per cent. have increased patellar and periosteal reflexes, while 70 to 75 per cent. have dermatographia; all these symptoms occurring much oftener than in non-tubercular people. An important practical point is, that in cases of neurasthenia in which the cause is not clear tuberculosis should be sought for.

Hysteria and tuberculosis approach each other closely. Even a slight tubercular infection, and still more fever, anaemia, and

insanition may in latent hysteria call forth such severe manifestations that the symptoms of tuberculosis may be masked by those of hysteria; such a condition has been called "hysterical phthisis." On the other hand in hysterical patients bleeding from the gums and throat may simulate phthisis. This connection must always be remembered in insurance cases presenting hysterical stigmata, or signs of traumatic neurosis.

Hysteria appears in tubercular patients much more rarely than neurasthenia. Sclierer in 1909 saw in his women's sanatorium in 470 cases 201 examples of neurasthenia and 20 of hysteria, and in 1910 in 477 patients 287 with neurasthenia and 21 with hysteria. This corresponds with our experience with male tubercular cases; to about ten neurasthenics there is only one hysterical case. Often the neurasthenia takes a hysterical tinge, or the two conditions may occur together as hysteroneurasthenia.

All these nervous conditions occur more often in early than in late cases of tuberculosis, in women than in men, and in persons of the upper than in the labouring class. With advance of the tubercular disease the intensity of the nervous symptoms diminishes; Ritter observed this especially after a hæmoptysis. It is characteristic of the neuroses in tubercular patients that they tend to assume a psychical character, and to become true psychoneuroses more often than in non-tubercular people. In this connection the traumatic neuroses may be remembered; the spread of tubercular infection after an injury explains this connection.

From this we pass to the peculiarities of character and slighter psychoneuroses of tubercular persons. There are many injurious influences which act continuously and often for a long time. Besides numberless personal, family, psychical, and physical factors, there are the action of toxic substances, miasmata, vasomotor changes in the brain, narcotics, and perhaps alcohol. All these influences not infrequently alter the psychology of tubercular persons in such a way that they react extremely quickly to stimuli, that marked differences appear in their character from that of their healthy days, and an increase in the ideas and perceptions is to be observed; the mind of the tubercular person assumes, as Köhler has stated, a psychasthenic tendency.

According to the generally received views of Heinzelmann two chief deviations from the normal psychical state occur: weakness of character and weakness of intelligence. These are shown, according to the individuality, environment, education, and breeding, by various changes in the psychical and affective

relationships of tubercular persons. The most frequent of these are: alterations of moods, frequent irritation and irritable weakness, a tendency to blissful emotions even if the original disposition was quite the opposite, marked egotism and ego-centricity, querulousness and grumbling, weaknesses of judgment and failure of the critical powers in distinguishing between things beneficial and injurious, and between mean and ruin, a tendency towards impulsive actions, periods of depression, optimism and self-deception, want of self-control, want of perseverance, over-estimation of physical powers, more rapid exhaustion of the mental faculties, failure of memory except in reference to the patient's own condition, and lastly, increased reaction to suggestion. Particularly characteristic of nervous tubercular persons is pathological changeability of mood, which may pass through all phases from melancholy ill-humour to emotional gaiety.

The older view that the sexual desire of tubercular persons is increased is still largely held. From our own observations we incline to the conclusion that even in states of great general weakness an increased sexual irritability and excitability is not seldom found, but that it is not particularly characteristic of tubercular cases. The sexual power of male tubercular patients although physically weak, emissions, and masturbations during sanatorium treatment, attempts at intercourse between the sexes in institutions which receive both men and women, in spite of their complete separation, and the statements of individual patients as to increase of sexual desires all prove but little. An increase in the libido sexualis of inmates of sanatoriums can be better explained by the circumstances of the treatment, such as the life in the open-air, the inactivity and absence of muscular exercise, the general bodily stimulus given by baths, frictions, and douches, the over-feeding and excess of albumens acting on patients, who are usually at the age of the greatest sexual activity, and are generally free from pains, and who, if they are incurable, often wish to take advantage of all pleasures of which they are still capable.

Prognosis and Treatment.

As to the prognosis of the neuroses and psychoses of tubercular patients it can only be said that they do not as a rule run the same course as the primary disease. If the practitioner considers carefully and critically the subjective symptoms of his patients, he will not be at fault in forming a diagnosis and prognosis of individual cases.

Besides the general treatment directed towards increasing the strength, the psychical management of the patient is of the

greatest importance. Emphatic statements of the seriousness of the condition and the importance of rigid treatment will be especially needed. It will be generally necessary to remove the patient from the home surroundings, since these often have unfavourable influences both on body and mind. This measure is frequently needed even as a preventative. As a prophylactic also the sexes should be separated in sanatoriums; in public institutions it is most necessary.

7. TUBERCULAR PSYCHOSES AND TUBERCULAR MENTAL DISEASE.

Symptomatology. Recent literature on psychiatry and tuberculosis do not support the idea of a general tubercular psychosis. Krapelin found that phthisis was very rarely accompanied by delirium. According to Binswanger tuberculosis only through loss of strength leads to conditions which are accompanied by the dementia of weakness. In the large material of sanatoriums only now and again in hundreds of cases will one see catatonia or maniacal delirium, the latter usually in the terminal stages of tuberculosis, and then the mental state may be due less to the phthisis than to a latent psychopathic disposition.

Still cases of moribund delirium, with wandering and slight excitement are taken as examples of a specific, tubercular insanity. Further, in advanced but not yet agonal cases of phthisis quite short transient periods of excitement in the form of acute hallucinatory paranoia with stupor may be met with. Also asthenic wandering with motor excitement, talkativeness, and hallucinations, in fact the complete picture of acute dementia, have been seen by Riebold in severe tuberculosis. It is interesting that Lischke could produce quite similar symptoms on himself by inhaling the emanations from tubercle bacilli, and considered that it denoted a specific reaction of supersensitiveness. Apart from such isolated observations the mental symptoms in the majority of tubercular patients consist of motor excitement in the form of mania; it is almost like an increase of the wellknown optimism and euphoria of tubercular patients into a psychopathological condition of maniacal excitement and delusions of grandeur.

If the phthisical patient is a chronic alcoholic, he is more easily attacked by delirium tremens than a non-tubercular person. There can be no doubt that many tubercular psychoses are nothing else than alcoholic delirium in a tubercular person, to which the weakness of the whole organism is a predisposing

cause. Alcoholic phthisical cases suffer also more severely from abstinence than non-tubercular alcoholics. We ourselves have so often seen an outbreak of delirium tremens from sudden and complete cutting off of alcohol on the entrance into sanatoriums of tubercular alcoholics, that we cannot doubt the existence of an abstinence delirium in these cases.

If we decline to accept the existence of a general tubercular psychosis, but concede the occurrence of psychoses of a tubercular origin, the question arises how psychical alterations in tubercular persons can be explained. As in typhoid delirium and psychoses of sepsis, there is with the psychoses of tuberculosis an overloading of the whole organism with toxin, which is capable of considerably disturbing the mental faculties. Further, there is probably a connection between the frequent occurrence of tubercle bacilli in the circulating blood and the histological changes in the nerve-cells, vessels and meninges of the cerebral cortex, which are found in phthisical cases even when there is no mental disturbance. A certain acquired or congenital tendency towards psychical abnormalities may act as a predisposing cause in individual cases, and explains the specific toxic action of the tubercle bacilli on the central nervous system and especially the cerebral cortex in cases of general weakness or in patients lowered by the use of alcohol or morphia.

The question whether tubercular persons are responsible before the law may be answered in the negative for all actions, which are done in a state of delirium or amentia. Only in exceptional cases will a combination of weakness of the intelligence and increase of the emotions give rise to a criminal tendency. In no case are the toxic effects of tuberculosis to be considered the same as those of alcohol in a criminal relationship. On the other hand, it may be possible to prove in criminal cases that the illegal act was done at a time when the character was altered by phthisis; if this is so the assumption of a partial irresponsibility or lessened responsibility will be justified, and must be considered in awarding punishment.

The close connection between tuberculosis and mental disease is indicated by the following figures: according to an inquiry made by Wulff in 1893 in idiot asylums, 48.6 per cent. of all deaths were due to tuberculosis; in 15.3 per cent. of the idiot asylums from 80 to 100 per cent. of the deaths occurred through tuberculosis. In 1903, of the 307 inmates in the Rastenburg Idiot Asylum, forty died, one of enteric and thirty-nine of tuberculosis. In the Hamburg Asylum, with 960 paralytics, Friedrichsberg found 269 cases of phthisis, i.e., 28.3 per cent. From

1877 to 1901 Holheim found, in the Hessian Asylum, that 25.1 per cent. of all the deaths were due to tuberculosis, and in the Hepperheim Asylum 22.4 per cent.; altogether tuberculosis occurs as a cause of death 3.9 times as often as in the mentally sound. The reason for these terribly high figures is in a small degree due to the still incompletely hygienic arrangements in asylums, and in a larger degree to the impossibility of dealing properly with the sputum of mental cases; it is usually swallowed, and often also some is smeared about. On the other hand, there is no marked affinity between any special form of mental disease and tuberculosis, such as exists between general paralysis and syphilis. Mental disease does not follow tuberculosis, but the latter follows the mental disease, and especially the removal of the patient to an asylum. That this is so is shown by the fact that while the number of phthisical patients afflicted with mental disease remains the same, the number of tubercular lunatics has very considerably diminished, owing to the improvement in the hygienic conditions of asylums and the measures taken to isolate those infected and to disinfect the sputum, linen, &c.

Prognosis and Treatment.

The prognosis of tuberculosis becomes worse if it is complicated by considerable mental disturbance. Also the course of mental disease is less favourable if the patient becomes infected with tuberculosis.

The treatment of psychoses in tubercular persons is not essentially different from that of those in the non-tubercular. Rest, good food, and plenty of fresh, pure air are the most important factors. The use of hydrotherapeutic measures must be strictly adapted to individual cases; in hopeless cases of tuberculosis narcotics need not be withheld. The removal from a sanatorium to an institution for mental cases may be necessary, though quite exceptionally. For the prevention of abstinence delirium it is preferable in the institutional treatment of tubercular alcoholics to cut the alcohol off gradually.

The treatment of tubercular lunatics in a special pavilion, apart from the general sanatorium, presents great difficulty, since in it a complete sub-division and separation of the tubercular cases, according to the form of mental disease would be necessary. It is simpler and cheaper to isolate the infectious cases in an asylum in separate rooms, and to see that in framing the measures suitable for the mental condition that the necessary hygienic precautions are not omitted. The prevention of overcrowding is still required in many asylums, with improvement in the ventilation and a more careful disinfection of the bedding, &c.

CHAPTER XI.

Tuberculosis of the Eye.

I. TUBERCULOSIS OF THE CONJUNCTIVA.

Anatomical Changes.

Tuberculosis of the conjunctiva may appear in the form of small, miliary, grey or greyish-yellow granules, which may either be isolated or in groups, and have but slight tendency to necrosis; or larger, rounded, papillary swellings may form, which ulcerate in places. Tubercular ulcers have a yellowish-red, tallowy base, or are covered with grey-red granulations. In their neighbourhood may be often seen small granules or exuberant growths of the conjunctiva. The disease is usually situated on the conjunctiva of the lids and in the folds, more rarely on the bulb.

Lupus of the conjunctiva is a separate condition. Lupoid ulcers are marked by their swollen edges and uneven base covered with granulations, which bleed readily. It is typical of the condition that it spreads from the skin to the conjunctiva, and like lupus of the skin tends to cicatrize at one point while it advances at another.

Microscopically tuberculosis of the conjunctiva shows the usual changes found in the disease of the mucous membranes with tubercles containing Langhans's giant-cells; tubercle bacilli cannot always be found in the sections.

Symptoms and Course.

The disease usually affects only one eye. Young people are chiefly attacked. So long as only granules are formed no symptoms are produced. When ulcers appear the lids become swollen and a purulent discharge appears. The disease runs a very chronic course and may last for years. The tubercular ulcers slowly spread and show but slight tendency to healing. Spontaneous recovery is only rarely seen, and then relapses usually follow. The ulcers may spread from the conjunctiva to the bulb and in severe cases cause deep destruction of the lids. The pre-auricular lymphatic glands usually swell quite early.

Tuberculosis of the conjunctiva may be primary. In the majority of cases it follows direct infection from outside, and is generally a purely local disease. That it appears comparatively rarely, though tubercle bacilli very often reach the conjunctival sac, is doubtless due to the fact that the bacilli cannot penetrate the normal epithelium, so that a lesion is necessary for the occurrence of infection. The idea of a bactericidal action of the tears (Valude) seems doubtful. Primary tuberculosis of the conjunctiva may long remain local; but it may be spread further by the lymphatics. Extension by continuity to the tarsus, the cornea, the lachrymal ducts and the nasal mucous membrane is rare.

Secondary infection of the conjunctiva from neighbouring structures, especially the nasal mucous membrane, is more common. The decision whether the disease is limited to the conjunctiva or not is very important for prognosis and treatment, since in the former case the diseased area can be radically removed. But if the eye is secondarily affected from the nose, complete recovery is much more difficult.

Diagnosis.

The diagnosis can be usually made easily by the naked eye; but there are several other diseases of the conjunctiva which may be confused with tuberculosis, or which may mask it. According to Königshofer nodules produced by trachoma, conjunctivitis follicularis and granulations of the conjunctiva will in many cases be found to be tubercular on bacteriological examination. The views as to the aetiology of exzematous conjunctivitis (scrofula, phlyctenula) and its connection with tuberculosis and scrofula are still at variance. In the cellular infiltration giant-cells can be easily found, but tubercle bacilli never; also the condition usually does not react to tuberculin. In severe cases the disease may lead to extensive, deep infiltration of the cornea, sometimes ending in necrosis. The assumption of a special specific microbe is apparently unfounded.

According to Fuchs the following ulcers may be confused with tubercular ulcers of the conjunctiva: ulcers in exzematous and pustular conjunctivitis, ulcers left after separation of necrotic tissue due to diphtheria, and after burns, those due to the infection of small foreign bodies, to the necrosis of a chalazion, a pustule, or pemphigus vesicle, and lastly epithelioma; very rarely small syphilitic ulcers may have to be considered.

The differential diagnosis may be made by the history, by the nature of the primary disease, by exclusion and by the result of treatment. A histological or bacteriological examination of a

small piece of excised tissue, or the inoculation of this into the anterior chamber of the eye of a rabbit will give certain results. In doubtful cases test tuberculin injections will be specially useful by producing a focal reaction. This is of the greatest importance from the point of view of treatment, especially of the tuberculin treatment, which is being increasingly favoured. The exact aetiological diagnosis is called for in the cases of vegetations conjunctivitis, which have been already mentioned, since tubercular phlyctenules according to Schütz and Videky can be cured by tuberculin and good food, while in cases of exudative phlyctenula tuberculin treatment has no effect, and over-feeding with albumens, fats, &c., is even contra-indicated.

Prognosis.

The prognosis in the first place depends upon whether the disease in the conjunctiva is primary. As long as it is limited to the conjunctiva the chances of recovery are not bad. Owing to the tendency to relapse, the radical treatment of the diseased foci does not always succeed. If the disease in the conjunctiva is secondary, or if it has already extended into the nose, the prospects of cure are not so good.

Treatment.

Cases in which complete removal of the disease seems possible may be treated by excision, cauterization or scraping, followed by applications of caustics or iodoform powder. Lactic acid (25 to 50 per cent. solution) has also been recommended. A general hardening treatment will often be necessary. Lundsgaard, by means of Finsen light, obtained very good results without any relapses in twenty cases of lupus and primary tuberculosis of the conjunctiva. Lately tuberculin has been increasingly used with success; Davids, Griffith, v. Hippel, Masing, Sauthoff and Schwartz recommend its use.

2. TUBERCULOSIS OF THE CORNEA.

Anatomical Changes.

Tubercular disease of the cornea usually takes the form of parenchymatous keratitis. Anatomically there is a thick infiltration of the posterior layers of the cornea, with a new formation of numerous vessels in the middle and posterior layers. The infiltration implicates the ligamentum pectinatum, the iris and the ciliary body; however, the affection of the cornea is often so slight that it cannot be detected clinically. The histological recognition of typical tubercles has led to the now current view, that the disease is more often tubercular than was previously thought. It has lately been held that tubercular parenchymatous

keratitis nearly always begins by the deposit of tubercle in the ligamentum pectinatum, and therefore that the keratitis is usually secondary. Cases of primary corneal tuberculosis with the development of peripheral tubercular foci, which gradually spread towards the centre and heal, leaving behind marginal or tongue-shaped opacities, and which sometimes also ulcerate, have indeed been described, but with doubtful correctness.

Symptoms and Course.

According to the general view the clinical picture of corneal tuberculosis does not differ at all from that of typical keratitis parenchymatosa, which is evident from the nature of the anatomical changes. The disease may, therefore, vary much in the form, extent, and intensity of the corneal deposits, and the amount of vascularization. The depth of the deposit and vascularization, the gradual spread of the infiltration till it reaches a usually considerable amount, and the absence of suppurative changes are typical.

Sometimes corneal tuberculosis takes the form of sclerosing keratitis, in which tongue-shaped opacities spread out from the limbus into the deeper layers of the cornea.

Corneal tuberculosis produces inflammatory symptoms, such as pains, photophobia or lachrymation. Nearly always there is more or less inflammatory complication of the uveal tract. It usually attacks both eyes, more often simultaneously than consecutively, and always runs a slow course.

Very rarely are corneal ulcers produced by necrosis spreading from the granulations in the deeper layers to the surface; such ulcers may affect the larger part of the cornea. There are no clinical characteristics of tuberculosis; tubercle bacilli can be found in the discharge. Their course is usually very slow.

Diagnosis.

The clinical diagnosis of corneal tuberculosis can only be made with difficulty, as there are usually no characteristic symptoms. The diagnosis gains in probability if hereditary syphilis, which causes 50 to 80 per cent. of the cases of parenchymatous keratitis, can be excluded, and if there is tuberculosis of another organ or an hereditary tendency. The result of a test tuberculin injection is often of great importance. Easlin in cases of distinct lues without signs of tuberculosis never saw a reaction; on the contrary in cases in which there was no sign of lues or in which both syphilis and tuberculosis were present, the general reaction was distinct, but there was no focal reaction. As characteristic of the tubercular form he reckoned the steep rise and rapid fall of the reaction curve, an observation which v. Hippel has confirmed.

The diagnosis of tubercular corneal ulcers, since they differ in no way clinically from non-tubercular forms, must likewise be made exclusive of by the use of tuberculin. Sometimes tubercle bacilli can be found in material taken from the floor of the ulcer.

Prognosis.

The prognosis of tubercular parenchymatous (interstitial) keratitis with regard to termination is favourable, since most cases recover with good or sufficient sight, but the disease may last for many months. Also the prognosis in tubercular corneal ulcers in the cases hitherto seen has been good, in no case was perforation met with. The prognosis in both forms and the duration of the disease has been distinctly improved since the introduction of tuberculin treatment.

Treatment.

The treatment during the progressive stage consists in the use of a bandage or dark glasses, warm compresses, and in dealing with complications in the iris and ciliary body by means of atropine. In the regressive stage to assist in the clearing of opacities calomel powder, or as a stronger method, yellow precipitate ointment 1 to 4 per cent, can be employed. The remedies must be used for a long time, and be changed from time to time, since the eye becomes accustomed to them. Internally mercury, iodides, and diaphoretics can be used as reabsorbents.

The local treatment of tubercular corneal ulcers is that of non-specific cases; in slight cases with not much discharge bandages, warm compresses, insufflations of iodoform, and atropine may be used. In severe cases operative measures, such as scraping or cauterization of the ulcers, after repeated application of 3 per cent. cocaine solution, are required.

General treatment directed against the tuberculosis is also very important. Tuberculin treatment is specially indicated, and has given as good results as in conjunctival tubercle. With its use recovery has been seen by Basser, Davids, Döhl, Emanuel, Erdmann, v. Hippel, Laas, Lichtenstein, Rohmer, Seathoff, Schoeler, Ullmann, Wilder, and others.

Ullmann and Schwartz have also seen good results with Marmorek's serum in cases of scrofulous corneal disease.

3. TUBERCULOSIS OF THE SCLERA.

Anatomical Changes.

Tuberculosis of the sclera appears as superficial and deep inflammation. To the naked eye it differs in no way from the non-tubercular processes. The same is true of the progressive and destructive forms of softening and necrosis.

Symptoms and Course.

There are no clinical characteristic signs of tuberculosis of the sclera. It is a rare disease, and usually arises from primary mischief in the iris or ciliary body, more rarely in the choroid. It usually assumes the form of deep scleritis with more or less circumscribed nodules. The so-called "tuberculoma of the conjunctiva bulbi," which is situated near the edge of the cornea, and forms a thick, tumour-like prominence, arises nearly always according to Reis not from the conjunctiva, but from the superficial layers of the sclera. Tuberculosis of the sclera attacks principally young people, but not children, and runs a very chronic course. Quite in early stages of the disease ectasia of the sclera and staphyloma may occur. Neighbouring parts of the eye may become implicated; severe injury may be produced by thick opacities in the cornea (sclerosing keratitis), by seclusion of the pupil, by opacities in the lens and vitreous, and by alteration in the shape of the eye with marked myopia and increase of pressure from ectasia.

Diagnosis.

The diagnosis of marked cases is easy; but slight ones may be difficult to recognize. Since the tubercular form of the disease has no special characteristics, the diagnosis must be made from the presence of other tubercular foci, or by means of tuberculin. According to v. Michel scleritis is usually due to tuberculosis or syphilis.

Prognosis.

Recently tuberculosis of the sclera has been cured by tuberculin treatment, so that a better prospect is opened up for a disease which was previously considered incurable.

Treatment.

Treatment till recently was quite ineffective, and consisted of the employment of the usual reabsorbent measures. The local treatment is symptomatic, and must be directed against the complications in the cornea and iris. In later stages of the disease iridectomy is usually required. Of late good results and even complete recovery have been obtained with the use of tuberculins by Brandenburg, Busse, Davids, v. Hippel, Reis, and Schœler. It is therefore necessary to arrive at a diagnosis as early as possible by means of a test tuberculin injection, and then to lose no time in commencing tuberculin treatment.

4. TUBERCULOSIS OF THE IRIS AND CILIARY BODY.**Anatomical Changes.**

Tuberculosis of the iris and ciliary body is anatomically the best known form of tuberculosis of the eye, since it is a result of experimental inoculation of tubercular material into the anterior

chamber of the eye of animals, and has been histologically studied in all stages. Three to four weeks after the infection the first signs of tubercular iritis appear in the form of small, grey granules. These increase, become confluent, gradually fill the whole anterior chamber, and finally break through externally. In man tuberculosis of the iris appears in quite analogous forms, either as disseminated, grey granules, affecting particularly the base of the iris, or as larger, conglomerate tubercles. Some tubercles may disappear, while others develop. One of the human forms of tuberculosis of the iris can be most closely reproduced in animals by the inoculation of sterilized tubercle bacilli into the anterior chamber.

The rarer form of solitary tubercle develops with or without the simultaneous formation of granules, and forms the granulation tumour, which was first described by v. Graefe in agreement with the views of Virchow. Haab first recognized the tubercular nature of this granuloma.

In advanced tubercular changes histological tubercles can usually be recognized, but only with difficulty in early cases. On the other hand, recorded cases show that tubercle bacilli are very rarely found in sections. But also in non-tubercular disease of the uvea nodules with epithelioid and giant cells have been found, especially according to Axenfeld, Hirschberg, and Rochat in sympathetic ophthalmia. Therefore the tubercular nature of the nodular form of iritis, which according to Michael is as common as the syphilitic variety (40 to 50 per cent. of all cases) is doubted in many clinics. Added to this such cases of iritis with formation of nodules not uncommonly heal spontaneously. Therefore the anatomical changes alone are not sufficient for the recognition of specific tubercular disease.

Symptoms and Course.

Disseminated tuberculosis of the iris and ciliary body appears as iritis (ciliary injection, contraction of the pupil, discoloration of the iris, precipitation and synechiae), the most characteristic sign being the formation of nodules. It is a disease of youth, and is often bilateral. It runs a very chronic, variable course, and has much tendency to relapse. Inflammation of the iris cannot be well separated from that of the ciliary body. Hyperæmia and exudation are the most common signs, while the inflammatory symptoms are generally very slight, as in the non-specific variety. The nodules may spontaneously disappear. The tubercular nature of cases of spontaneous recovery has been proved by the result of animal inoculation of excised portions. In progressing, relapsing cases the nodules increase, become

confluent, and with severe disease may take the form of plastic iridocyclitis, leading to complete atrophy of the bulb.

Solitary tuberculous of the iris is likewise usually found in young people up to the age of 20; hitherto only unilateral cases have been seen. It appears as a new formation, with or without accompanying granules, and does not produce the symptoms of iritis. The swelling increases, breaks through the cornea and grows externally. It then necroses and the bulb atrophies. Solitary tubercles may appear in the ciliary body as in the iris.

Tuberculosis of the iris and ciliary body is nearly always a secondary disease. Primary tuberculosis is only possible from infection through a perforating wound; Fuchs has observed such a case. All other cases recorded as primary must have been due to a hæmatogenous infection of the iris from some other latent malade, clinical symptoms of which are absent. According to Krückmann tuberculosis of the iris is often secondary to glandular disease. It is very rarely seen with pulmonary tuberculosis.

Diagnosis.

Since anatomical examination is often not sufficient to determine the specific tubercular character of small nodules appearing in the iris, the clinical diagnosis is still less possible. Non-specific nodules are seen in many general diseases, such as leukaemia and pseudoleukaemia, also in sympathetic ophthalmia. The name *ophthalmia nodosa* has been given to a disease produced by the hairs of caterpillars, which may perforate the conjunctiva and cornea, enter the iris, and there produce severe inflammatory signs. The reddish-yellow nodules of syphilitic iritis papulosa, which are of the size of a pin's head or larger, are not to be confused with the milky grey, tubercular granules, shining through the surface of the iris. The diagnosis of tubercular iritis may be supported by finding other signs of tuberculosis, but cannot always be thereby made certain.

Solitary tubercle may be mistaken for other non-pigmented swellings, e.g., sarcoma, syphilitic papule or gumma. The following points may be useful: tubercle usually appears before the age of 20, it contains no vessels, and near it small tubercular granules can be sometimes found. Syphilitic swellings are situated at the edge of the pupil or ciliary body, they may appear at any age, and contain a few vessels; other symptoms of syphilis may often be found, and they disappear under mercury. Sarcoma appears very seldom in young people, it causes iritis later than the other affections, and contains more numerous vessels.

The diagnosis being so difficult it is now generally recognized that it is extremely important to use the subcutaneous

tuberculin test, which may be followed by a focal reaction (increase of the irritative symptoms, photophobia, ciliary injection, and according to v. Michel possibly an eruption of tubercles).

Prognosis.

Before the use of tuberculin treatment the prognosis was shortly as follows: slight cases may recover, not uncommonly spontaneously, while severe cases usually end in loss of sight and of the eye. Since v. Hippel has worked out the method of tuberculin treatment in these cases, the prospects of healing in the vascular tissue of the iris and ciliary body are quite good. Even cases of tuberculosis of the iris, in which enucleation was being considered, were completely cured with retention of the sight.

Treatment.

The symptomatic treatment consists of attacking the iritis with atropine, perhaps combined with cocaine, with warm compresses, and if the inflammatory symptoms are particularly severe with application of 6 to 10 leeches to the temple.

The general treatment must be directed as early as possible against the tubercular constitution. In suitable casesunction or diaphoretic treatment may be used. Operative measures are rarely required for isolated nodules only; they sometimes succeed, but lead to a dissemination of tuberculosis. Occasionally good results have been obtained by the introduction of iodoform into the anterior chamber (Haab), by blowing air into it (Koser), or by subconjunctival injections of betol (Pfuger). In all severe cases enucleation of the eye was necessary, to prevent a further spread of tuberculosis.

Since v. Hippel published his results, tuberculin treatment has been generally employed for tuberculosis of the iris and ciliary body with excellent results, so that enumeration of authorities and the records of cases is no longer necessary.

5. TUBERCULOSIS OF THE CHOROID.

Anatomical Changes.

Tuberculosis of the choroidal membrane appears, like that of the iris and ciliary body, first in the form of disseminated or miliary tubercle, as one sign of general miliary tuberculosis. The tubercles affect chiefly the posterior part of the eye in the neighbourhood of the veins, and may be either single or in numbers of thirty to sixty or more. The chronic form of tubercle of the choroid may appear as single areas of diffuse thickened granulation tissue or as solitary tubercle. Anatomical examination shows that the latter are formed of numerous

granules lying close to each other, the ones in the centre being usually caseous.

Symptoms and Course.

Miliary tubercles of the choroid appear in about 75 per cent. of all cases of miliary tuberculosis, often first in the last stages of the disease, and are of great diagnostic importance, since in doubtful cases they may determine the existence of miliary tuberculosis. The eyes show outwardly no alteration; the patient may notice a difference in the sight. The diagnosis can only be made with the ophthalmoscope. Small yellow or pale-red spots with distinct contour are seen in the fundus. They increase in size within several days, and at the same time new ones appear. They reach at the most a third of the size of the optic disk.

The chronic form may remain stationary for a long time as a diffuse thickening. It then resembles choroiditis disseminata. Small foci have been not rarely seen to heal spontaneously. The disease may spread to the retina and cause it to become separated. Even a metastatic tubercular panophthalmitis has been observed by Luitge.

Solitary tubercle of the choroid is a rare disease of young people, and has a chronic course. It is secondary to tubercular disease of other organs, especially the brain. If other tubercular foci cannot be found, it will be because they are latent. With the ophthalmoscope a large light-coloured swelling can be seen in the choroid. If small spots can be found near it, it will confirm the diagnosis. The only symptom is usually alteration of sight. A progressing solitary tubercle gives the subjective and objective signs of a growing tumour. The tubercle may perforate the sclera, and then necrose.

Diagnosis.

Miliary tuberculosis of the choroid can be easily recognized by the ophthalmoscope, and in difficult cases leaves not a doubt as to the nature of the general condition. In contrast to the spots of choroiditis disseminata choroidal tubercles increase in size and number, and they are not pigmented. Under the ophthalmoscopic picture of disseminated choroiditis tubercular changes may be hidden. It is important for diagnosis that the ordinary non-specific form is seldom accompanied by other signs of tuberculosis (only five times in 238 cases according to Maier). In this form the tuberculin reaction may establish the diagnosis; Haab saw in one case redness of the ciliary region and conjunctiva, and in another haemorrhage near the papilla. Solitary tubercle is more easy to recognize with the ophthalmoscope; the tubercle nature of the swelling is indicated by small, light spots near it (tubercular

granules). In cases in which its growth is progressive it can be distinguished from other tumours, such as glioma, by the relatively early appearance of iritis. Also the proper use of tuberculin may produce a focal reaction.

Prognosis.

The miliary form, being part of general miliary tuberculosis, indicates a fatal ending. Tubercular inflammation appearing in the form of choroiditis disseminata often recovers spontaneously, so that its prognosis is not bad. The solitary form before the use of tuberculin always ended in loss of the eye, and there was also the danger of the tuberculosis spreading. Now the prognosis is very much better.

Treatment.

Apart from symptomatic treatment and the use of the usual reabsorbents the treatment of chronic choroidal tuberculosis in severe cases until lately consisted of enucleation of the bulb, or, if perforation of the sclera had occurred, better still in exenteration of the orbit, although operation was not resorted to in earlier cases on account of the possibility of spontaneous recovery. Of recent years the operations have steadily declined, owing to the good results achieved by tuberculin. Cramer saw recovery in a large isolated tubercle of the choroid with severe damage to the cornea; Lubowski had a similar case. Axenfeld also saw a tumour-like tuberculoma of the choroid cured under tuberculin. Augstein, Basse, Dietz, Herrenschaund, Schoeler, and Stock recommend, too, tuberculin treatment on the ground of its marked results.

6. OTHER TUBERCULAR EYE DISEASES.

Of the other tubercular diseases of the interior of the eye we may shortly mention first the opacities and the later hemorrhages of the vitreous, which occur without other ophthalmoscopic signs. Apart from the fact that the vitreous is sometimes affected by tubercular disease in its proximity, it may apparently be itself the seat of tuberculosis without neighbouring parts of the eye being implicated. This is shown by the experimental researches of Deutschmann. Axenfeld and Stock, on the grounds of their observations during the last ten years, have found that the vitreous hemorrhages of young people which frequently accompany retinitis proliferans are often due to tuberculosis. Hemorrhages into the vitreous usually originate in the vessels of the retina, which are easily affected in tuberculosis, perhaps by the action of the toxin. Here again tuberculin has not only been useful for the diagnosis and the establishment of the aetiology of the condition, but has also been effective in the treat-

ment. Cases of complete and lasting clearing of the vitreous with recovery of good sight have been often recorded, as by Schöler and Igerscheimer.

Tubercles are only found in the retina when the uvea and optic nerve are also affected. A very rare case of pure retinal tuberculosis, in which the whole extent of the retina was affected, while the choroid was only secondarily infiltrated, has been recently described by Komoto; on histological examination of the enucleated eye the disease was found to have begun in the neighbourhood of the papilla.

As by no means rare affection is tuberculosis of the optic nerve, which, like most forms of ocular tuberculosis, attacks chiefly young people. The disease may attack the nerve at any point from the chiasma to the papilla, or the nerve sheath; it usually occurs with tubercular meningitis. With the ophthalmoscope the signs of papillitis are usually found. Tuberculosis of the optic disk or the retina may appear in the form of a tumour. If an operation is considered, it can only be a question of enucleation of the bulb or exenteration of the orbit. Tuberculin again offers a good prospect in this disease, which formerly could only be weakly resisted. There are many cases in which it has given good results in optic neuritis, papillitis, and retrobulbar neuritis of a tubercular nature (Schroermann, Schmaudigel, Schöler, and others).

The bones, periosteum, and cellular tissue of the orbit, and the muscles and nerves of the eye may be affected by tuberculosis, which is usually secondary. In the external eye it is of interest that the chronic affection of the Meibomian glands, chalazion, has by many authorities been declared to be often tubercular. It is more probable that it may be a question merely of a foreign body tuberculosis in the thickened secretion or epithelial debris of the Meibomian gland. Tubercle bacilli are only found in rare cases; inoculation experiments nearly always fail. The differential diagnosis must be made from tuberculosis of the tarsus, which originates in the conjunctiva and may appear as a chalazion.

More important is tuberculosis of the lachrymal gland, ducts and sac, which again usually appears in young people. The infection occurs secondarily from conjunctival tuberculosis, or more often from the mucous membrane or bones of the nose. Occasionally the disease in the lachrymal sac may be the first sign of lupus of the nose; the recognition of the primary disease is important for prognosis and treatment.

Tuberculosis of the lachrymal gland is characterized by the

appearance of a usually hard swelling, which is not tender on pressure and may reach the size of an almond; it is found in the upper and outer angle of the orbit, and is movable, not adherent to the skin, but connected with the deeper parts. The duration of the disease varies much; inflammatory symptoms are nearly entirely absent. The diagnosis must be made from sarcoma. The treatment is surgical, and radical cure is difficult to obtain. There are up to now no observations on the result of specific treatment.

Our knowledge of tuberculosis of the lachrymal sac has been considerably increased by Brihak's work at the Freiburg University ophthalmic clinic. The disease usually appears as a *Idenorrhoea* of the lachrymal sac, sometimes as a dacrocystitis with fistula. On the grounds of the frequency of the condition (twenty-five cases in the last year) it seems that tuberculosis of the lachrymal sac occurs much more often than is generally thought, and that it may be the only recognizable form of tuberculosis from which the patient is suffering. Some observations show that the tubercular character could be more often detected if a series of sections were made. The cases are suspicious in which the discharge does not contain the usual septic organisms. Sometimes the symptom complex observed by Axenfeld decides the diagnosis; this consists of a doughy-elastic resistance, which does not disappear on pressure; and although there is epiphora, yet fluid can pass through the canals rather slowly yet without great hindrance into the nose. A focal reaction may be obtained after a tuberculin injection; and a general reaction is also valuable, since in this case the dacrocystitis may be already tubercular, or will readily become infected. The best treatment is early radical removal of the diseased structure. Recovery spontaneously or as a result of treatment is not impossible, but the physiological function of the lachrymal sac is usually destroyed. Relapses may be avoided by energetic application to the granulations, and if necessary, to neighbouring foci of caustics.

7. TUBERCULIN IN DISEASES OF THE EYE.

The views as to the frequency of tuberculosis of the eye are still divergent, since in many forms the tubercular aetiology is not yet sufficiently recognized. According to recent observations, especially those of Michel, tuberculosis plays a very much larger part in the production of diseases of the eye than was formerly thought. On the other hand we have seen that there are various diseases, appearing in the form of nodules, which neither clinically nor anatomically can be recognized as being

tubercular; even tubercular ulcers clinically often have not the characteristics of tuberculosis.

In such cases the use of tuberculin for the differential diagnosis is of the greatest importance and is generally employed.

The cutaneous reaction is little employed in ophthalmology and is not likely to be so. All the same a negative result is strongly against the probability of ocular tuberculosis. A positive result can only be of value for diagnosis when other tubercular foci can be excluded, and tuberculosis of the eye may be secondary to quite slight forms of disease. Therefore the cutaneous reaction has but little importance in ophthalmology.

There is so much risk of causing severe mischief by the conjunctival reaction, when tuberculosis of the eye is present, that its use is altogether condemned by many ophthalmologists (Adam, Brons, Collin, Siegrist, Stargardt, Stuelp, Waldstein, and others).

The subcutaneous method with a production of a focal reaction is of the greatest value, and may absolutely establish the diagnosis. The diagnostic injections, however, must be given with care. According to v. Hippel, who has had the largest experience of tuberculin in diseases of the eye, strong focal reactions are to be altogether avoided. He warns against commencing with large doses and against increasing them too rapidly, since in several cases of tuberculosis of the cornea necrosis of the layers lying over the diseased focus has been seen when the reaction has been too strong. v. Hippel therefore advises the following doses for diagnosis, deviating from the method of R. Koch: initial dose always 1 c.mm. of old tuberculin; if that gives no reaction to be increased to 2 or 3 c.mm.; and final dose, 5 c.mm. In most cases a prompt and undoubted reaction will be thereby produced. In children according to the age correspondingly smaller doses are to be used. Stock and F. Schoeler think that in adults a higher dose than 1 c.mm. is hardly necessary for diagnosis.

In the description of the various forms of tuberculosis of the eye we have mentioned that rapid healing with preservation of the sight has been obtained in the severest cases with tuberculin treatment without the use of any other method. The effect of tuberculin is the more striking, since previously treatment was usually powerless to arrest most cases of tuberculosis of the eye.

Old tuberculin has given good results; but preference must be given to the new tuberculin T.R.; and lately the bacillary emulsion has been recommended from many sides, as it seems to surpass T.R. in its effects, and particularly to prevent relapses.

For the tuberculin treatment of diseases of the eye, v. Hippel has worked out a special method, which has generally been employed in ophthalmology. It consists in giving with care small doses, and avoiding strong reactions. The possibility of watching in the eye the focal reactions and the course of healing step by step, makes the employment of tuberculin practically easy in these cases, and gives indications for the doses, the interval between them, the maximal dose and the duration of the treatment. Krückmann, Reis, Kuhnt state that those cases of tubercular disease of the eye are most influenced by tuberculin treatment which gave to very small doses distinct focal reactions. Further information can be found in our book on "Tuberculin in Diagnosis and Treatment."

In suitable cases other methods of cure may be used in addition. F. Schöeder states that tuberculin increases the utility of other methods and makes the eye more tolerant of them. With regard to the energetic reabsorbent measures, it may be remarked that diaphoresis had better be avoided with recent inflammation, and inunction treatment only used in strong people, who are free from tuberculosis in other organs. If these measures are used, they must be employed carefully and gradually.

CHAPTER XII.

Tuberculosis of the Ear.

According to the copious literature aural tuberculosis is more common in children than in adults. Lœci found in the bodies of tubercular children that 80 per cent. had open suppuration of the ear with bacilli, while in adult phthisical cases E. Frankel found that only 6 per cent. had macroscopic tuberculosis of the ear, and Habermann, with the use of the microscope, could only detect it in 25.8 per cent. In adults, males are affected considerably more often than females. Herzog found middle-ear disease in 31 per cent. of tubercular men and in 9 per cent. only of women; in 14 per cent. of the men there was a direct connection between the disease in the ear and tuberculosis, and this was not so in one woman. According to Schwabach's figures 84.8 per cent. of cases of tubercular suppuration of the ear in males there were 18.2 per cent. in females.

Contrary to the still general view a very considerable percentage of chronic inflammatory conditions of the ear are of a tubercular nature. It is necessary for the practitioner to take more interest in the diseases of the ear in general and aural tuberculosis in particular, as these cases are commonly, at present, left to specialists.

I. TUBERCULOSIS OF THE EXTERNAL EAR.

Anatomical Changes.

The external ear is the most exposed to infection by the tubercle bacillus. The auricle and the external meatus may become primarily infected through an excoriation of the skin. Secondary infection is also possible from discharge due to tubercular disease of the middle or internal ear, or from spasm in open pulmonary tuberculosis. In the outer ear there are three characteristic forms of tuberculosis: Lupus, tubercular perichondritis and nodular tuberculosis of the lobe of the ear.

Symptoms and Course.

Lupus of the external ear causes no symptoms and does not differ in appearance from the disease in other parts of the body.

Tubercular perichondritis generally causes burning and itching. It consists of a doughy swelling with a red elevation of the concha; the disease may break through externally or may spread inwards from the cartilage. The neighbouring lymphatic glands swell and become tender.

Nodular tuberculosis of the lobule of the ear forms a thick swelling of the size of a cherry-stone, which consists of small cell infiltration and small tubercles. The skin is of a bluish colour, and not movable. The neighbouring lymphatic glands are affected.

Diagnosis.

The diagnosis of lupus of the external ear can be made without difficulty, if tuberculosis is thought of. We may refer to the chapter on tuberculosis of the skin. Doubt may be settled by a test tuberculin injection.

Tubercular perichondritis is characterized by its slow development, the caseous pus containing tubercle bacilli and the fungoid granulations. After discharge of the pus typical ulcers and fistule may form, and if the cartilage becomes infected necrosis and sequestra.

Nodular tuberculosis is localized to the lobule, and especially to the spot where it is pierced. This explains the limitation of this form to the female sex.

Prognosis.

In primary inoculation tuberculosis of the external ear the prognosis is good; in forms complicated with some other focus in the body it becomes worse.

Treatment.

The treatment of lupus of the ear is the same as that of lupus of the skin. On account of the good cosmetic results a combination of light treatment and tuberculin is to be recommended; if this does not lead to complete recovery, surgical measures can be employed.

Tubercular perichondritis and nodular tuberculosis are to be treated either by excision and by free opening of the nodules. If the cartilage is affected, deformity of the ear must be expected, unless a timely operation is performed.

2. TUBERCULOSIS OF THE MIDDLE EAR.

Tuberculosis of the middle ear must not be confused with the middle-ear suppuration of phthisical patients. The latter is not due to the tubercle bacillus, but the pulmonary disease acts as a predisposing cause by producing acute middle-ear catarrh, and in keeping up the discharge. The middle-ear disease of tuber-

cular persons is characterized by the fact that very often, at the commencement of the disease, there is no marked reaction in the tympanic cavity. In its further course it tends to produce a reactive inflammation in the form of hyperplasia and sclerosis of the bony wall, or destructive processes may predominate.

This is explained by the bad nutrition and diminished resistance of the phthisical patient.

Tubercular changes in the middle ear may affect the tympanic membrane, the tympanic cavity, the tube and the mastoid process. These different forms so often go together and arise from each other, that they must be considered at the same time.

Anatomical Changes.

In the last stages of phthisis and in miliary tuberculosis (true tubercles sometimes appear on the tympanic membrane, which necrose more or less rapidly one after the other, and form small perforations; sometimes the drum is rapidly destroyed. A specific but mild variety of tumour-like formation on the drum has been also described by Preysing. But tubercular infection of the drum is rare compared with that of the tympanic cavity. The changes in the drum consist of swelling and redness followed by perforation, and all transitions between mild chronic inflammation and acute suppuration may be seen. After entry of the tubercle bacilli into the tympanic cavity the mucous membrane becomes studded with miliary tubercles of a grey or yellowish-white colour, which proceed to ulcerative necrosis and the formation of granulation tissue. This gives rise to a more or less copious discharge, which under the influence of secondary septic organisms becomes purulent, and, if there is retention and decomposition, fetid. Spread of infection leads to destruction of the ligaments, to necrosis and separation of the ossicles, to caries of the wall of the tympanum or antrum of the petrous bone, to destruction of the labyrinth and to the deposit of tubercles in the facial nerve and therefore of facial paralysis. Also the meatus acusticus internus and the acoustic nerve may be implicated.

Tuberculosis of the tympanum is not rarely the result of disease in the Eustachian tube, the infection either spreading by continuity from the mouth or pharynx to the mucous membrane of the tube, or being conveyed by the lymphatics from tubercular tonsils and spreading along the submucous lymphatic tissue of the tube. Tubercular ulcers of the tube spread deeply, often into the cartilage, and miliary tubercles may frequently be found near their edges.

Like infection of the drum, tuberculosis of the mastoid

antrum usually occurs early in the course of tubercular middle-ear suppuration. There are also cases in which the disease of the antrum is not tubercular, although that in the tympanic cavity is. The mucosa of the mastoid antrum nearly always partakes in the same pathological changes as that of the tympanic cavity; it may become hyperæmic and swollen and furnish a discharge, which, like that in the tympanic cavity, may be mucoid, purulent or undergoing mixed infection. The interior of the antrum may become full of crumbly, caseous masses or of granulation tissue. By spread of the inflammation to the bone caries with its many results will be produced.

Symptoms and Course.

Middle-ear tuberculosis may be the first manifest sign of tuberculosis in an otherwise healthy person; but this is rare. The primary disease occurs most readily in children, and in practice is limited to those cases in which chronic middle-ear suppuration offers a favourable ground for infection, which may occur either from outside through a perforation in the membrane or through the Eustachian tube.

Secondary tubercular otitis media is much more common. It usually arises from the mouth or nasopharynx, material containing bacilli derived from the lung, larynx, mouth, pharynx or nose being conveyed through the Eustachian tube to the middle ear. This is favoured by forcible expiration, sneezing, hawking, choking, vomiting and blowing the nose with the nasal passages closed. That men are affected with middle-ear tuberculosis much more than women is explained by the fact they are much more liable to all non-tubercular diseases of the upper air-passages. The great frequency of tubercular otitis media in weakened cases of phthisis is due to widening of the lumen of the tube in consequence of absorption of fat round the cartilage and of atrophy of the mucosa, the tube thus becoming more permeable to particles of sputum.

The Eustachian tube itself is not rarely the site of disease in adults; but more frequently in infants and children.

An infection through the blood is possible, and has been proved anatomically, in disease of the mastoid. It is not yet decided whether tuberculosis of the mastoid antrum is more often primarily osseal, the infection occurring through the blood, or whether the disease more often starts in the tympanic cavity. The great frequency of the primary antral form in children is recognized; in them 15 per cent. of all cases of inflammatory mastoid disease are tubercular.

Isolated tuberculosis of the drum causes deafness and slight

subjective auditory sensations, but no distinct pain. The course is very chronic, generally no progress in the disease is to be observed.

True tuberculosis of the middle ear presents two well-marked forms. One variety progresses slowly. With slight or no pain, but perhaps with tinnitus and a feeling of obstruction in the ear, the drum becomes moderately inflamed and slightly red and swollen. Soon after multiple perforations of small size appear. These increase gradually, join together and produce an irregular defect, through which the inflamed mucosa of the tympanic cavity is visible. In other cases the perforations visibly increase, and the whole drum may be quickly destroyed, so that the handle of the malleus stands out; destruction of the ligaments and separation of the ossicles soon follow. It is rare for perforations to be absent; if so, slight swelling and redness with feeling of pressure and gradual alteration of hearing may persist for months. Characteristic therefore of the gradual form of tubercular otitis media are the absence or slightness of pain, the scanty signs of inflammation of the drum, and the occurrence in the last stages of phthisis.

The second form of middle-ear tuberculosis is quite different. It develops suddenly with severe, often unbearable, pains spreading to the teeth, and marked swelling of the drum with great alteration in the hearing. The drum is more or less rapidly destroyed, fetid pus is produced, which covers the granulations and necrotic areas, and the disease spreads to the bones, the antrum and the labyrinth. Thus the characteristics of this acute, fulminating form are sudden commencement, with severe pains and marked deafness, much inflammation of the drum and middle-ear and tendency to extension to the mastoid and internal ear.

Lately Jørgen Möller has described a hitherto unknown form of middle-ear tuberculosis with the following characteristics; marked deafness with subjective noises, considerable bulging and diffuse injection of the drum, which is of a dull whitish-yellow colour and very opaque; it is caused by diffuse tubercular infiltration of the drum and mucosa of the middle ear. The tubercular character has been proved by microscopical examination of portions of the excised drum.

The course of middle-ear tuberculosis cannot be described in general terms; that of neither of the first two forms can be reckoned on; in one case it may be favourable, in others a series of grave complications may arise in the blood sinuses, the carotid, the jugular vein and the endocranium, the latter are especially common in children. The development of miliary tuberculosis

from implication of the sinus and erosion of the carotid and jugular with fatal hemorrhage are very rare complications. Mller's form runs a uniformly good course with a distinct tendency to spontaneous healing, but often only after more or less damage has been wrought.

Tuberculosis of the Eustachian tube, as long as it is isolated, may produce subjective auditory sensations and a feeling of fullness in the ear. When it extends to the tympanic cavity the condition becomes clearer.

Tuberculosis of the mastoid often causes no, or only very slight, symptoms, so that it can be easily overlooked. In the primary osteal form the whole mastoid process to the periosteum may be affected, without characteristic symptoms being produced. In children mastoid tuberculosis usually runs a purely local and favorable course. Facial paralysis is rare, and indicates, when it is present, extensive disease. Tuberculosis of the mastoid starting in the tympanic cavity usually runs a slow course, the discharge for a long time is slight, but usually fetid. When the secretion becomes very copious and offensive, a sequestrum must be thought of; there will be also pains in the head, tenderness on pressure, fever and general loss of strength.

Diagnosis.

Tuberculosis of the drum is easy to diagnose on account of the yellow or yellowish-red granules of the size of a pin's head, which stand out distinctly from the slightly reddened or pale tympanic membrane. As a result of caseous necrosis perforations are formed, through which the red or swollen mucous membrane of the middle ear can be seen. The appearance is typical of isolated tuberculosis of the drum in terminal phthisis.

The diagnosis of tuberculosis of the middle ear is difficult as long as the drum remains unperforated; there is no discharge. The examination of the discharge is specially decisive if tubercle bacilli can be found. But this occurs in only one-third of all the cases of middle-ear tuberculosis; the bacilli can most often be found soon after the formation of the perforation; in later stages these are more rarely discovered, and then only with difficulty. They must not be confused with smegma bacilli and other acid-fast bacilli. According to Berardini tuberculosis can be distinguished by the increase of lymphocytes in the discharge without other histological signs.

For the examination of nasal discharge for tubercle bacilli the following method may be recommended: After thorough cleansing and disinfection of the external meatus this is to be plugged for twelve to twenty-four hours with sterile wool, and the discharge is then to be striped out

with a little sterile water and collected. The particles are to be carefully spread on a cover-slip—when the discharge is copious it may first be treated with antiformin—and the preparation stained with carbol fuchsin and decolourised for twenty-four hours in 1 per cent. hydrochloric acid in alcohol; it can then be counter-stained in the usual way, and the preparation thoroughly examined. Still more certain is the growth of a pure culture (or inoculation on guinea-pigs).

For the detection of large frimbriocytes staining with Löffler's methylene blue is sufficient.

There are various signs in the appearance of the drum, which are indicative of tubercular disease of the middle ear. Multiple perforations are the rule in tubercular otitis, and very exceptional in the purulent form. The perforations are most often in the anterior and posterior lower quadrants, extensive destruction of the lower half of the drum frequently occurs.

The otoscopic examination of the tympanic cavity also furnishes some information. First of all a rapid, steady, painless destruction of the whole middle ear without any general symptoms is indicative of tuberculosis. We find the mesial wall of the tympanic cavity most often affected, and the floor relatively seldom. The malleus and incus are diseased in the same frequency and intensity, while the stapes long remains intact, and is very rarely entirely absent. Other pathognomonic signs of tuberculosis are the rapid ulcerative destruction of the mucous membrane of the tympanic cavity, the adherent, discoloured layer on the wall, roughness of the bones with slight formation of granulations and foetid secretion, formation of small sequestra and the absence of epidermic growth over the muosa. The changes will usually only be found with the help of the probe. But it must be emphasized that probing the ear is only to be undertaken by those practitioners who have had great experience in instrumental examination of the ear, and who are certain of the topographical anatomy.

The functional aural changes are more important for the practitioner. Even at the beginning of tubercular middle-ear disease there is marked and regular diminution of the hearing. In about a half of all such cases the whisper can only be heard within narrow limits, in the other half not at all; only about 5 per cent. of the cases can hear at a distance of more than 16 in. When the whisper can be no longer heard the conversational voice is to be tried; and here the higher and lower tone-characters are to be distinguished. The lower tone characters (words like *bruder*, *patzer*, *orgel*, *morgen*, *ohr*, *onkel*, *uhr*) are badly heard in all diseases of the middle-ear, but words with high tone character (like *stige*, *wetter*, *kissen*, *bissen*, *secks*)

only, as a rule, if the labyrinth is implicated. Since the latter is the case in nearly all cases of middle-ear tuberculosis, the loss of hearing of the higher tones is generally considerable. Likewise pathognomonic for tuberculosis is disproportion in the perception of the deeper tones of Bezold's instrument and the voice; while the hearing is bad for the conversational or whispering voice; a deep note of the tuning-fork is generally heard surprisingly well.

Lastly facial paralysis on the same side has some value for the differential diagnosis, since it is usually produced by extensive bone disease with much swelling of the mucous membrane; it occurs very much oftener with tubercular suppuration than with non-tubercular; it generally lasts very long, and is often incurable.

Tuberculin injections for diagnosis have been approved by Schwartze, Lucæ, Bezold, Schwabach and Ferri, in spite of the objection that the local reaction in cases of middle-ear tuberculosis generally causes great pain, and the local reaction itself cannot be always harmless. In children the cutaneous test may be critically employed.

For the diagnosis of tuberculosis of the Eustachian tube the use of the posterior rhinoscopic mirror is necessary, by which means tubercular ulcers and other changes at the pharyngeal opening are visible. If the Eustachian catheter is used, bacilli may be found in discharge adhering to it. In any case the diagnosis is difficult and in early cases impossible.

The conditions for the recognition of tuberculosis of the mastoid are not better. By external examinations the tubercular mastoiditis cannot be distinguished from the purulent form, and the diagnosis by tuberculin is contraindicated. It is not justifiable to assume in the presence of middle-ear tuberculosis that inflammatory changes in the mastoid are necessarily tubercular; that can only be certain if the lateral bony wall of the antrum is perforated, the neighbouring glands swollen. The primary bony form of mastoid tuberculosis is usually first diagnosed by operation; abundant granulations and a line of demarcation in the bone are against tuberculosis; formation of sequestra, which often involve a large extent of the centre or periphery of the bone, is in favour of tuberculosis. If the suppuration and growth of granulations lead to a fistulous perforation of the lateral bony wall, then the diagnosis may be made from the examination of the discharge, and the formation of a fistula is suggestive of tuberculosis, even if bacilli cannot be found. On the other hand sub-periosteal extra-dural abscesses point to non-tubercular

mastoid disease. The mastoid glands are constantly affected in tuberculosis, and only exceptionally so in non-tubercular otitis.

Prognosis. The prognosis of tuberculosis of the Eustachian tube and the drum is like that of the middle ear, bad, when it occurs as a complication of advanced lung disease. On the other hand, tubercular disease of the middle ear, when the general health is good and the disease in the lung stationary or latent, may subside and recover to a certain extent, and the discharge quite cease, while the perforation, deafness and whistling noises in the ear persist. But this is exceptional; the suppuration usually becomes chronic. In this lies the great danger, which must not be underestimated. In adults persistent tubercular suppuration of the middle ear leads in quite a third of the cases to purulent disease of the labyrinth, while in children it still more frequently produces tubercular complications such as meningitis.

For the same reasons mastoid tuberculosis due to disease of the tympanic cavity has an unfavourable prognosis, while the outlook in the primary bony form is not bad; since it is a local disease the chances of recovery are better than in tuberculosis of the middle ear.

Treatment. The treatment of tuberculosis of the middle ear must depend first of all on the nature of the primary disease. But in all cases paracentesis of an un-perforated drum is incorrect treatment. If the disease occurs in cases of phthisis in which a fatal termination is no longer to be prevented, careful syringing is alone to be employed. We recommend with Bezold only one form of injection, a concentrated solution of boric acid, which can be made as required by adding two tablespoonfuls of crystallized boric acid to two pints of hot water; the fluid must be used at a temperature of 100° to 100° F. When there are large defects in the drum, insufflations of boric acid, iodoform or a combination of both (10 to 1) may be employed; less useful are insoluble powders such as dermatol, xeroform, aristol, nosophen, &c. The introduction of 10 per cent. iodoform emulsion and of iodine, pot. iodide and glycerine with guaiacol (iodine .2, pot. iod. 2, guaiacol 1, glycerine 20) has been recommended. J. Möller employs in the form of middle-ear tuberculosis described by him the energetic application of trichloroacetic acid and lactic acid, when loss of substance has occurred. If the general health is good, such cauterizations and the use of chromic acid may be considered, but their application must be left to specialists. That the patient must be put under the best hygienic and climatic conditions possible goes almost without saying.

The specific treatment of tuberculosis of the middle ear, the experiences of which were formerly bad, has lately given better results. Thus Voss, from the observation of several cases of chronic middle-ear tubercular disease, especially the so-called suppuration of the mucous membrane, considers them very suitable for specific treatment. After long, fruitless treatment with other methods he cured such cases by systematic injections of bacillary emulsion. For acute tuberculosis of the middle ear we do not consider the tuberculin treatment suitable; Voss also recommends the greatest care.

Of the physical methods of treatment we have found the various modifications of hyperæmia to be most useful. Passive hyperæmia from congestion of the head may be produced by an elastic bandage an inch broad carried round the neck, so that no pains are produced; if the patient is thin, pads may be placed under it; the congestion causes distinct swelling and discoloration of the face. For the production of active hyperæmia in the region of the affected ear the hot-air douche may be used. Klapp, from his experience in the Bonn clinic, recommends Hahn's apparatus, in which the funnel is provided with a ball-joint and the mouth of the hot-air tube with a wooden cover, so that the patient himself can direct the hot air on the affected ear, and can remove and replace it as necessary. The treatment should be commenced with a temperature of about 100° C., and raised at later sittings to 120° C. Pains must not be produced; marked headache, dizziness, and weakness are contra-indications. Hyperæmia may also be produced by suction applied to the external meatus. It must be particularly noticed, that the amount of suction must be as little as possible, that it must never be started suddenly, nor continued too long. We have applied the suction glass at first for five minutes a day, and if the results are good increased to two periods of five minutes with a three-minute interval. By this means exacerbations in tubercular middle-ear disease can be often controlled, and the chronic condition improved.

Tubercular ulcers at the entrance of the Eustachian tube may with the throat mirror be cauterized with 20 to 50 per cent. silver nitrate solution, and if not improved burnt with the galvanocautery. Schwartz after two or three thorough applications say even very deep ulcers cicatrize in a week. Preliminary anaesthesia with 20 per cent. alypin solution and expert handling of the cautery are necessary in this procedure.

Tuberculosis of the mastoid in strong patients with slight disease elsewhere requires surgical treatment, consisting of the

exposure and removal of the foci by the chisel or other radical means. Fever, severe night sweats, sleeplessness and copious suppuration may indicate operation even with advanced lung tuberculosis, since the ear disease increases the symptoms and the loss of strength. As to the time and form of the operation the specialist must decide. But the practitioner must seek his aid in time, i.e., as soon as the diagnosis is made, if it appears that the foci can be completely removed. The possibility of recovery is then not less in the primary bony form than in non-tubercular mastoiditis.

3. TUBERCULOSIS OF THE INTERNAL EAR.

Anatomical Changes.

Tubercular infection of the labyrinth, no matter by which route it is produced, leads to various changes according to the duration and intensity of the infection. Acute and chronic labyrinthine inflammation can be distinguished. Tuberculosis of the labyrinth may on the one hand lead to necrosis, and on the other new formation of connective tissue and bone may be found on *post-mortem* examination. The final result is mechanical injury to the labyrinth from reactive inflammation and suppuration.

Symptoms and Course.

The internal ear is most often affected from tuberculosis of the middle ear or petrous bone, more rarely from tubercular meningitis. Tubercular infection through the blood has not yet been seen for certain. When the labyrinth is affected there are severe subjective sensations (noises of a whistling, throbbing, or beating character), and partial or complete deafness. Also the so-called "labyrinthine symptoms" (vertigo, disturbance of equilibrium, nausea, vomiting, auditory hyperaesthesia, and caloric nystagmus) are more or less well marked.

The injury to hearing and disturbance of static equilibrium vary according to the position and extent of the disease in the cochlear or vestibular part of the labyrinth, but on the whole they are extremely obstinate.

Diagnosis.

The diagnosis of tubercular inflammation of the labyrinth rests on the discovery of hardness of hearing and deafness, with marked subjective auditory symptoms and of signs of increased irritation of, or of damage to the labyrinth.

Whether certain qualitative methods of examining the hearing by means of Weber's, Rinne's, or Schwabach's tests, and by Galton's whistle can give reliable information as to the presence of tubercular disease in the labyrinth, has been long disputed.

According to the views of many recent authors they can to a certain extent. The practitioner is therefore advised to test with a medium tuning fork (C_4). The results which can be thus given are shortly as follows: In Weber's test—placing the tuning fork on the crown of the head while it is giving its maximum vibrations—the patient will hear the sound in the healthy ear longer than in the other, or exceptionally the sound will only be heard by the healthy ear ("lateralization"); but the results of this test are not reliable for the diagnosis of labyrinthine disease. Rinne's test—placing the vibrating fork on the mastoid process, and when it can no longer be heard there, bringing it close to the external ear—enables a comparison to be made between the air and bone conduction. In disease of the labyrinth it is usually positive, i.e., the air conduction lasts longer than the bone conduction, a state which corresponds with the normal. Rinne's test is only of diagnostic value in conjunction with Schwabach's test. The latter consists of producing the maximal sound of the tuning fork, placing it on the vertex, and measuring the time from striking the fork till the sound is no longer heard. By this means the duration of the perception of bone conduction is measured, which for normal people with tuning fork middle C should be twenty-five seconds. In affections of the organs of auditory sensation the duration of bone conduction is shortened. Lastly, testing with the so-called Galton's whistle shows a diminution of the perception of upper notes in labyrinthine disease. Therefore when the tuning fork note is lateralized to the sound side, when air conduction lasts longer than bone conduction, when the duration of the perception through the bones is shortened, and lastly, when the upper notes are not heard, then any marked diminution in the audibility of the whispering voice must be due to labyrinthine disease.

Even more important and not more difficult is the observation of caloric nystagmus. This rhythmic movement constantly appears in ear diseases, and consists in a slow lateral movement of the eyeballs, followed by a rapid, jerky, backward movement, when thermal irritation (syndring the ears with cold or hot water) is applied to the vestibular apparatus; the irritation is conveyed to the semicircular canals, leads to changes in the flow and pressure of the endolymph in them, and so causes the movements of the eyes. According to Bárány this caloric nystagmus, if water above the body temperature is used, is towards the ear that is being syndringed, and if the water is below the body temperature the movement is towards the opposite side. While this caloric nystagmus can be produced with all healthy labyrinths,

if the latter is affected the nystagmus is increased, but if the semicircular canals are completely destroyed by suppuration the nystagmus is lost. Therefore in existing middle-ear tuberculosis if there is a doubtful increase of the caloric nystagmus, it points to an extension of the disease to the internal ear; if no nystagmus is produced, the labyrinth in its vestibular portion is suppurating; if there is also complete deafness, the cochlear portion containing the organ of Corti is probably also destroyed by suppuration. On this basis the condition of the labyrinth can be approximately determined, if the results of the tests in the affected ear are compared with the sound side. For comparing the results of the test it is useful to measure the time taken from beginning the syringing to the appearance of the nystagmus, or the amount of water required to produce the symptom.

For testing for caloric nystagmus the following method may be used: The ear is best washed out by means of an irrigator with the patient in an upright, sitting position, and the head bent backwards 45° to 60° . The cold water at 50° to 55° C., and the hot at 30° to 35° C., must not be introduced at too high a pressure. The irrigation must often be continued for a minute or more before the nystagmus is produced; when this has occurred the flow of fluid must be stopped, as otherwise sudden dizziness, vomiting of the bowels, and vomiting may occur. Since the cold water is better borne than the hot, it is advised to commence with it. Obstructions in the meatus (wax, plugs of wool, &c.), which hinder the action of the fluid on the labyrinth, must be first removed.

When the introduction of fluid into the ear is contra-indicated by recent rupture of the drum or old defects, cold air can be blown in with Politzer's bag. This procedure is of great practical importance for the detection of fistula of the semicircular canal. When in the horizontal canal a fistula has formed in consequence of carious destruction of the bony capsule, on air being blown into the meatus there will be horizontal nystagmus to the affected side, and on the air escaping, to the other side.

For the production of "diastolic responses" one must go carefully to work, and not raise the pressure of air in the meatus suddenly or by jerks, but slowly and gradually, to avoid damage to the semicircular canals and instead of infection from the middle ear.

The further question whether the labyrinthine disease, when detected, is tubercular, must be determined by the occurrence of tubercular antecedents, or of active tubercular disease elsewhere, especially in the middle ear or petrous bone. In any case, the practitioner will do well in such cases to consult a specialist. This is important, in order that treatment may not be neglected; and also the diagnosis may be very difficult if the disease is bilateral, or when the middle and internal ear are both affected.

Prognosis.

With regard to hearing the prognosis is bad. Also there is a tendency for the disease to advance, and especially to spread to the interior of the skull.

Treatment.

In advanced cases of tuberculosis the treatment must be symptomatic, and is limited to counter-irritation of the skin in neighbourhood of the ear. For this purpose hourly frictions with spr. ammon. aromati., spirit. formicar., balsam Hoffmann &c. or applications of cantharides plaster to the mastoid process, the place being frequently changed (flying vesication), or spreading antimonial ointment on the bare skin have been recommended. In severe cases also the methodical use of leeches and cupping glasses may be ordered. Narcotics are to be used if necessary.

If the general health is good the labyrinthine operation may be performed, which lately Urbanschtisch in a case of tubercular disease of the middle ear and labyrinth has carried out with good results. As to the indications and form of operation to be employed only experienced otologists can decide according to the nature of the individual case.

The best treatment is preventative; *i.e.* the most careful management of cases of tubercular middle-ear disease.

Prophylaxis.

The prophylaxis of aural tuberculosis may be attended to in various ways. The custom of introducing a dirty finger or sputum-infected articles (toothpick, handkerchief) into the ear is to be forbidden. Phthisical mothers must be warned against kissing their children on the ear, and also against wiping out the infant's mouth with dirty fingers or handkerchiefs, or infecting the feeding bottle from sputum. Piercing the lobes of the ear, if performed, should be done with strict cleanliness; earrings worn by phthisical patients should be disinfected. Sneezing with the nose held must be reckoned as dangerous. The doctor must take care not to convey infection by catheters, bougies, or Politzer's bag. Children with scratches and excoriations in the external ear should be treated till they are well, and any serofulous symptoms at the same time attended to. Tubercular affections of the cervical glands and tonsils in children should receive special care, and, if necessary, be removed. Lastly, for the protection of the patient and others the infective discharge from the ear must be rendered harmless.

CHAPTER XIII.

Miliary Tuberculosis.

In contrast with the chronic course of phthisis in miliary tuberculosis there is an acute tubercular infection, in which the tubercle bacilli are spread broadcast, a formation of numerous tubercles in nearly all the organs rapidly ensuing. Only quite exceptionally is it a primary condition from external infection, which would require to be very massive. As a rule it is secondary and produced from within, being an auto-infection from a tubercular focus already existing in the body, which by opening into a blood-vessel or lymphatic suddenly floods a whole organ or the whole body with tuberculosis virus. One can distinguish acute miliary tuberculosis of a single organ, e.g., the lungs or serous membranes, and acute general miliary tuberculosis.

Anatomical Changes.

The primary focus of a miliary outbreak may be a small and obscure caseous tubercular nodule, whose detection during life is impossible, and may be difficult even at the autopsy. Thus the condition may be considered to be due to a primary exogenous infection, whereas as a matter of fact it arises from an already existing, but latent, tuberculosis.

The special ætiological question is hotly contested, whether the miliary outbreak is due to the sudden entrance of a large number of tubercle bacilli into the lymphatics or blood-stream, or whether the scattered bacilli, which are constantly entering the circulation, can multiply in the blood on account of an increased predisposition. Ribbert supports the latter view; he adduces the varying size and age of the miliary tubercles and the easy detection of tubercle bacilli in the blood. As a point of entrance of the constantly renewed invasion of the blood by tubercle bacilli, he mentions the numerous tubercles in the intima of the arteries of the lungs.

On the other hand, Weigert, Benda and Cornet consider that the bacilli invade the blood in large numbers, particularly from

the tubercles in the vessel wall. These tubercles of the vessel, which have already been described, were first noticed by Weigert especially in the large pulmonary veins, and by other authors in the veins in the rest of the body, and also in the heart, the aorta, the pulmonary artery, and the thoracic duct.

It is also certain, that with the necrosis of tubercles in the blood-vessels and lymphatics and the formation of tubercular ulcers enormous numbers of bacilli enter the blood. Almost regularly—in 95 per cent. of the cases—these tubercles and ulcers of the vessel wall can be discovered in miliary tuberculosis; on the other hand, they are absent when miliary tubercles are not present.

The varying ages of the miliary tubercles noticed by Ribbert may be explained by the existence of several tubercles of the vessel wall causing infection. On the other hand, v. Hansemann has found that the larger and older miliary tubercles are absent in acute cases, and that in chronic cases of miliary tuberculosis they are no longer true tubercles, but caseous bronchitic nodules and small areas of caseous hepatization. Also in recent years tubercle bacilli have been found in the blood of chronic cases of tuberculosis much oftener than was previously thought, though miliary tuberculosis is not a frequent occurrence in phthisis. The organism is generally able to deal with and overcome the small number of bacilli which are constantly entering the blood, as explained by recent observations on the pathological and anatomical character of phthisis, while it succumbs to a sudden massive infection of the blood. It therefore seems that Weigert's view of the aetiology of miliary tuberculosis rests on the better foundation.

Tubercles of the wall of small vessels are not the only cause of miliary tuberculosis. Chronic aortic and arterial tuberculosis and sieve-like perforations of the veins from adjacent tubercular foci may also cause the condition. Without the vessel wall itself being diseased, miliary tuberculosis may be also caused by perivascular tubercular nodules rupturing into the lumen of a pulmonary vessel, by a small cavity opening into a vein, by rupture of a caseous gland into the aorta, or in connection with parturition and abortion. In the last-mentioned condition some form of genital tuberculosis, generally in the uterus, first brings about the abortion, and then by an opening into the vascular system of the uterus infects the whole body, especially the lungs.

The localization of the miliary tuberculosis depends on the site of the rupture of the tubercle of the vessel wall; thus miliary tuberculosis of the kidney may be set up by a nodule on the renal artery, or of the lungs by a focus in the right side of the

heart, the vena cava, the thoracic duct, or the aorta; while general miliary tuberculosis arises from infection of the blood in the left side of the heart, e.g., from the pulmonary veins. Also the tubercle bacilli after rupture into the thoracic duct, which occurs particularly often, the vena cava or the pulmonary artery may first reach the pulmonary circulation, and then infect all the organs through the systemic system.

To sum up, we may say of the aetiology of miliary tuberculosis, that tubercle bacilli lodged at some spot in the body there produce either no ill-effects on a chronic form of tuberculosis, but on entering the blood-stream in large numbers cause an acute, fatal condition. The degree, amount, and rapidity of these injurious effects and also the entry of bacilli into the circulation depend on various factors. Favourable to these conditions are a youthful age of the patient and everything that tends to mobilize the tubercle bacilli already existing in the body, such as inflammatory swelling of the glands during measles and scarlet fever, operations on tubercular tissues, pregnancy, the puerperium, abortion, great mental disturbances, and traumatism. That miliary tuberculosis may be the indirect result of an accident affecting an existing focus is seen in a case in which a chronic encapsuled tuberculosis in the axilla after a severe bruise to the shoulder within three weeks led to a miliary infection of the lungs and meninges.

Pathologically, miliary tuberculosis is characterized by the appearance of miliary tubercles in numbers varying with the vascularity of the organ and its position in the blood-stream. The individual tubercles vary in size according to the duration of the disease from scarcely visible points to nodules, which are softening in the centre or throughout; they give the organ on section a characteristic granular appearance, on account of the numerous prominences generally surrounded with a red zone. These miliary tubercles are found more or less numerous in the spleen, kidney, liver, mucous membranes, meninges, choroid and serous surfaces; in the last position they not uncommonly produce a clotting of fibrin, and effusion into the serous cavity. Infarcts may occur in the spleen or kidney and hæmorrhages in the brain. The spleen is constantly enlarged, the liver frequently so.

Symptoms and Course.

The clinical symptoms of miliary tuberculosis are produced both by the general intoxication and the local damage caused in the individual organs by the formation of tubercles. This explains the indefinite, variable nature of the disease.

The commencement is usually sudden, but may be gradual, lasting several days with prodromal symptoms, which may vary according to the localization. The typhoid, pulmonic, and meningeal forms have been distinguished.

The typhoid symptoms are a consequence of general intoxication, and consist of fever, increase in the pulse-rate, fall of blood-pressure, and bad general condition. The fever runs no characteristic course, it is usually high, continuous, remittent, or intermittent, sometimes also of the inverse type. In old patients the fever is usually absent or is only slight. The pulse is 120 to 150 a minute, it is small, weak, and not uncommonly dicrotic. The blood-pressure is correspondingly diminished. Bleedings from the nose, bowel, or retina are very rare. The bad general condition is shown by the complete loss of appetite, by persistent diarrhoea, and by the toxic effect on the nervous system. The softened spleen is constantly enlarged, sometimes to three or six times its normal size. Herpes, roseola, and albuminuria are more rarely seen.

The pulmonic form of general miliary tuberculosis has the same symptoms as acute miliary tuberculosis of the lungs, the relative frequency of which is due to the fact that the lungs act as a filter to the tubercle bacilli in the blood. Besides the fever and rapid pulse the lung symptoms are prominent. They consist of frequent, generally dry cough, dyspnoea, and even orthopnoea. In marked contrast with the symptoms the physical signs are only slight, and consist of scanty, diffuse, catarrhal signs, of accentuated vesicular breathing, and of indefinite, rapidly changing, accessory sounds, chiefly numerous, fine râles, which can be heard quite early. According to whether the miliary nodules in the lung are small, but of the same size, or vary in development and caseation, the two forms of uniform or non-uniform pulmonary miliary tuberculosis can be distinguished. The amount of inflammation of the parenchyma of the lung and bronchial mucosa is different in the two varieties, and the amount of these changes again determines the presence of a mucoid or mucopurulent expectoration. The damage to the pulmonary circulation is shown by very accelerated, superficial breathing, acute distension of the lungs, and particularly characteristic cyanosis, especially of the nose and lips, with a very pale face.

The symptoms are only clearly marked if the patient has also bronchopneumonia; if the lung parenchyma is not implicated, then extensive miliary tuberculosis of the lung may occur without symptoms. Towards the end oedema of the extremities occurs, and also involvement of the pleura and pericardium, producing

pains, friction rubs, and later effusion; the fluid is not uncommonly hæmorrhagic.

In the meningeal form of military tuberculosis the general toxic symptoms, such as headache, vertigo, numbness, apathy, and stupor rapidly increase. Vomiting, sleeplessness, contraction of the muscles of the neck, cramp, clonic spasms, delirium, frequent groans and cries, with fever and slightly increased but very weak pulse, point to the brain being affected. In this stage the discovery of tubercles in the choroid is of importance.

Diagnosis. The diagnosis of military tuberculosis is the more difficult the fewer local signs there

are of the implication of various organs, especially at the beginning of the disease. In children and old people the objective signs of the pulmonary form are often so little characteristic that the diagnosis is more a matter of conjecture than certainty. Of special importance in such cases is the examination of the lungs with the Röntgen-rays during complete cessation of respiration. The Röntgen picture of military tuberculosis of the lung is particularly characteristic at a time when other signs are still absent; and consists of a very typical, diffuse, fine marbling of the lung areas, which according to Levy-Dorn is due to inflammatory hyperæmia round the military nodules. If at the same time an old tubercular focus can be found at the apex or hilus of the lung, or anywhere else in the body, or if the history indicates a previous tubercular disease, our attention is the more directed towards military tuberculosis, and an examination of the blood for tubercle bacilli becomes specially necessary. This must be done early, if it is to be of value for diagnosis, since the bacilli can usually be found in large numbers in the circulating blood for only a short time after their entrance. The most suitable method of examining the blood has been described in Chapter VII.

If there is a probability of the meningeal form of military tuberculosis the examination of the cerebrospinal fluid for tubercle bacilli is still more likely to be successful. The process has been described in the chapter on Tubercular Meningitis. In these cases the ophthalmoscopic examination of the eye is also very important, since in 75 per cent. of them six or more tubercles can be found in the choroid, in the form of light, whitish-grey, or yellow, rounded or elongated spots with faded edges.

The differential diagnosis must be made from pneumonia, intermittent fever, septicæmia, acute mania, acute non-specific bronchitis (in old people), capillary bronchitis (in children), and from labour, abortion, and puerperal infection. By exclusion the correct diagnosis may be often arrived at.

Very difficult is the differential diagnosis between general miliary tuberculosis and typhoid. Apart from the results of bacteriological and serological tests, the presence of a typhoid epidemic, a typical typhoid fever curve, a slow pulse at the commencement of the disease, the tongue at first with red edges and later diffusely red, the pea-soup diarrhoea, and a dicrotic pulse indicate typhoid; tubercular antecedents, exposure to tubercular infection, a tubercular focus in some organ, irregular fever, marked dyspnoea or cyanosis with slight signs in the lung, pleuritic or pericardial complications, herpes at the commencement, and early loss of strength are in favour of miliary tuberculosis. Bronchitis, splenic tumour, leucopenia, and diazo-reaction may be present in the typhoid form of miliary tuberculosis as in enteric fever.

Puerperal disease is so difficult to distinguish from miliary tuberculosis that it has been strongly recommended that every case dying after child-birth should be examined *post mortem*, both for the purposes of accurate puerperal statistics and in the interests of the doctors attending confinements. This is an extreme view, but in all feverish conditions after child-birth miliary tuberculosis is to be thought of. Indicative of miliary tuberculosis, besides the already mentioned symptoms, are meningeal signs, absence of rigors, and the discovery of tubercle bacilli in the blood or of tubercles in the choroid; while in favour of puerperal fever are injuries in the genital tract, renal hæmorrhage, and the presence of septic organisms in the blood.

The use of test tuberculin injections is strongly contraindicated if there is even a suspicion of miliary tuberculosis, while the cutaneous test is found to throw no light on these cases. But a very positive conjunctival reaction is very much in favour of miliary tuberculosis.

Prognosis.

The prognosis is absolutely bad. Acute miliary tuberculosis is still incurable; in the several cases that have been recorded the correctness of the diagnosis is doubtful. Sometimes after a more chronic course lasting weeks or months, with periods of alternate improvement and relapse, the fatal issue is reached. This occurs especially in that form of pulmonary miliary tuberculosis in which the nodules are not uniform.

Treatment.

The treatment of miliary tuberculosis is chiefly symptomatic; the strength must be maintained by a light, easily digestible fever diet, the heart supported by cardiac tonics, and the fever treated by hydropathic measures and drugs. If the fever prevents the taking of food,

single doses of pyramidon (2 to 5 gr.) may be given two to three hours before food. Pains, severe cough, and breathlessness may be met with the ice-bag and morphia or its derivatives.

According to v. Hansemann acute miliary tuberculosis, being the most definite form of tuberculosis, should respond to tuberculin treatment; but this is not true, for the simple reason that the organism in miliary tuberculosis is no longer capable of undergoing active immunization. The treatment of miliary tuberculosis by tuberculin is therefore not only useless, but is contra-indicated.

CHAPTER XIV.

Scrofula.

Pathology and Ætiology.

AFTER the word scrofula had been used for decades as a general term for all chronic forms of inflammatory disease associated with swelling of the glands, Laennec identified it with tubercular disease of the glands, and Virchow with a special pathological constitution, connected with defective assimilation. The abnormality of assimilation consists in deficient utilization of the nutritional substances brought to the tissues by the bloodstream and in a defective tissue formation from the insufficiently utilized materials; from this results an overloading of the whole lymphatic system. The nutritional defects in the tissues also explain their abnormal sensibility to external irritation and their marked tendency to react with inflammatory changes of a special character, which run a chronic course, relapse frequently, and show but slight signs of healing and formation of normal new tissue. The anatomical foundations of scrofula consist of hyperplasia, proliferation, and degeneration particularly in the glands, the lymphatic organs, the skin, the mucous membranes, the subcutaneous tissues, the bones, and the joints.

The discovery of the tubercle bacillus has not advanced the comprehension of the pathological anatomy of scrofula much further, chiefly because the comprehension of scrofula, according to the presence or absence of tubercle bacilli, has undergone many changes and is still so differently considered by different authors, "that one can scarcely find in two text-books the same definition, description and limitation of scrofula" (Littler). We will return, therefore, to the question after considering the causes and nature of scrofula.

The results of histological and bacteriological examinations of manifest cases of scrofula show that it is a separate disease, and distinguish it from tuberculosis. Neither in scrofulous

disease of the skin nor in the chronic lymphatic hyperplasia need tubercle bacilli or their special products of regressive metamorphosis be found. Further, the result of the tuberculin test, which is the most definite and specific reagent for detecting tubercular infection, is negative in scrofulous children, and shows that the condition cannot be considered as identical with the tubercular disease of childhood. But Fœr still considers that no typical cure of scrofula has been brought forward which did not react to the cutaneous test.

It is certain that scrofulous children very frequently give a strong reaction to the cutaneous test, and that the characteristic eczematous, catarrhal and inflammatory hyperplastic changes in the skin, mucous membranes and lymphatic systems, not only sometimes, but even relatively frequently, develop into local and general tuberculosis. Further, the lymphatic glands, which are very typical of tuberculosis, even when they are only swollen, very often show tubercle bacilli on section or as the result of animal inoculation. According to Weichselbaum and his school a lymphatic gland infected with tubercle bacilli need not always show specific changes.

In this debated question of the aetiology of scrofula Cornet emphasizes the importance of the tubercle bacillus. He distinguishes three forms of scrofula: a tubercular form caused by the tubercle bacillus, a non-tubercular pyogenic form and a mixed form of both infections. Thus in scrofula there is both a primary and constant congenital abnormality of constitution, and a secondary and variable but extremely important factor of bacterial infection. According to the infection being with tubercle bacilli alone, or with pyogenic organisms, or with a mixture of both, follows the production of local or general tuberculosis of childhood, of pure scrofula, or of scrofulo-tuberculosis. In the last case it is not always possible to determine whether the tubercular infection is grafted on to a previously existing scrofulous condition, or whether the symptoms, which at first were considered to be scrofulous, were not from the first due to an infection with tubercle bacilli. This uncertainty does not change the fact, that every person who clinically is at first only suffering from scrofula, runs the danger of becoming tubercular, and that even the greater part of scrofulous children become tubercular.

The further question arises, whether tubercle bacilli can enter the body of scrofulous persons and lodge there, without leaving behind any recognizable changes at the point of entrance, or whether the scrofulous changes in the skin and mucous membrane prepare the ground for their existence; and further whether

in order to arrest the infection the glands must be previously altered by bacterial or toxic action or not. To these questions no certain answers can yet be given.

The simplest explanation of the connection between scrofula and tuberculosis is that of v. Baumgarten, who considers that they are both forms of congenital tuberculosis.

According to Soltmann, only the liberated toxin of the tubercle bacilli passes through the placenta from the mother to the fetus and produces a non-bacillary, hereditary, toxic tuberculosis, which is scrofula.

A. Czerny separates a symptom complex belonging to scrofula from tuberculosis, and designates it an exudative diathesis after making sure of its non-tubercular nature. The exudative diathesis of Czerny is therefore a non-tubercular form of scrofula, and is a congenital, abnormal tendency appearing in children, whose parents suffered from the same condition, from psychopathic disturbance, or from gout, diabetes or obesity, or more rarely from tuberculosis. The condition may show itself even in infancy either as malnutrition or as abnormal fairness, in both cases it is a consequence of the same defect in assimilation, especially mal-assimilation of fats. The principal signs of the exudative diathesis, according to Czerny, are "cartilaginous" tongue, porrigo, seborrhoea, prurigo, circular caries of the teeth, hyperplasia of the tonsils, tendency to frequent catarrh of the air-passages and phlyctenular conjunctivitis.

Also Heubner distinguishes a symptom complex corresponding with the exudative diathesis, of a constitutional non-tubercular nature, and calls it lymphatism.

Escherich speaks in such cases of a lymphatic constitution, and with Moro upholds the view that scrofula is nothing else than tuberculosis developing in the form of lymphatic constitution (status lymphaticus of Escherich, lymphatism of Heubner, exudative diathesis of Czerny and Moro). The exudative diathesis is to a certain extent the precursor of scrofula; the former being primary and congenital, and the latter a secondary, acquired condition, caused by tubercular infection. Only from this diathesis can scrofula be produced, since in non-lymphatic (non-exudative) children the results of tubercular infection are shown by quite other symptoms. One can accept this definition of Moro and describe scrofula shortly as the tuberculosis of lymphatic (exudative) children. So much the more are we obliged to hold fast to the primary, decisive components, which are characteristic of the scrofulous habit, and to connect scrofula with a definite symptom complex, which is neither purely exudative nor purely tubercular.

Symptoms and Course.

For long have two clinical forms of scrofula been distinguished, the torpid and the erethistic.

The torpid form is characterized by a heavy build, a faded colour, puffy appearance, coarse features, thick swollen nose, prominent lips, pendulous abdomen, visibly enlarged glands, sluggishness of the bodily functions and phlegmatic temperament; it is the result of slow, deficient tissue changes.

The erethistic type is shown by a slender build, delicate pale skin, scanty adipose tissue, slight muscles, sensitive vasomotor system (flushing and sudden pallor), blue sclerotics, bluish-white shining eyes, swollen lymphatic glands, active temperament and excitable nerves; it is the consequence of greatly accelerated tissue changes.

In both forms the hyperplastic swelling of the glands is the most prominent feature. They are the best sign of the peculiar characteristics of scrofula, such as the exceptional irritability of the lymphatic elements or the tendency to proliferation. Thereby is produced congestion of the lymphatic vessels, and this in turn causes deficient nutrition in the glandular tissues, ending in caseation.

The glandular swellings in the torpid form affect chiefly the peripheral glands, and in the erethistic form especially the visceral glands, the bronchial more than the abdominal. The peripheral lymphatic swellings occur chiefly in the nape and side of the neck, and the region under the jaw, the axilla and groin are more rarely affected; the swelling is primary, and independent of any affection in the region draining into the gland; it occurs without fever or pain; the glands vary in size from that of a pea to a walnut, or larger; they swell up and subside again, and may disappear altogether, or remain in the same condition. The swelling of the glands of the neck may reach a high degree, so that the neck looks like that of a pig (*scrophu* = swine, *scrophula* = a small pig); the glands may remain hard for a long time. If pyogenic infection of the glands occurs through the skin or mucous membrane, they suppurate and adhere to the skin, which becomes oedematous and of a bluish colour; finally they break externally and form sinuses, which discharge a whitish, flaky, purulent fluid, and at last heal, leaving extensive scars. Thus in the first stage of scrofula there is a primary hyperplastic lymphoma, which becomes secondarily infected with streptococci, staphylococci, or tubercle bacilli; only in the last case will the scrofulous lymphatic glands be tubercular. The form of tubercular infection of the glands has been further

differentiated by Abramowski, in such a way as to explain the very considerable difference between the two forms of scrofula; he considers that the torpid form arises from the alimentary tract through infection with bovine bacilli, and that the erethistic form is produced by infection through the air passages with human bacilli. It is a hypothesis for which much may be said.

The other characteristics of scrofula are the affections of the skin and mucous membranes.

On the face can be seen in the region of the cheeks, chin, mouth, nose, eye, and ear, and more rarely on the hairy scalp, papular, vesico-pustular, squamous or seborrhoeic eczema (pottigo). This eczema may lead to localized tuberculosis of the skin through entrance of bacilli. But one must not consider every case of chronic eczema, especially the eczema on the face and scalp of infants associated with digestive disturbance, to be due to scrofula.

There are many scrofulous signs connected with the eye, ear and nose. Characteristic changes in the eyes are thickening of the edges of the lids, and inflammation of the Meibomian glands, conjunctivitis lymphatica, herpes of the conjunctiva and cornea, ulcer of the cornea, phlyctenular keratitis with the subjective symptoms of photophobia, blepharospasm and lachrymation; in the ears serous and seropurulent otitis media; and in the nose rhinitis, coryza, and ozena.

The irritating secretion from the mucous membrane leads further to other changes, such as the characteristic crusts, cracks, and swelling of the upper lip, moist eczema and impetigo of the external ear and meatus, of the inner and outer angle of the eye, in the eyebrow, eyelids and cheeks, and irregular arrangement of the eyelashes. Acute, furunculosis and subcutaneous abscesses with necrosis and ulceration may also occur. Changes in the skin of the trunk and extremities are not common. Chronic forms of urticaria, intertrigo and eczema of the skin folds (scrophulus, lichen urticatus, intertrigo) and rarely diffuse furunculosis may be met with.

Among the affections of the mucose chronic pharyngitis is a constant sign of scrofula. Compared with other forms it is characterized by swelling of the submucous lymphatic tissue, which in consequence of the longitudinal arrangement of the follicles leads to raised folds of mucous membrane on the posterior wall of the pharynx; the mucous membrane has a wavy appearance. The lymphatic ring is affected at the same time in the mouth and nasopharynx. The tonsils, the palatal tonsil and the crypts of the tongue are reddened and inflamed, and produce

a glairy, purulent mucus; the cartographic tongue and circular caries of the incisor and canine temporary teeth complete the picture. Adenoid vegetations also form part of the chronic hyperplastic inflammation of the nasopharynx; but they must not be considered by themselves to be evidences of scrofula, since they frequently occur in children who are not scrofulous. Salge lays stress on this and recommends that adenoids without other signs of scrofula should be considered as the lymphatism of Heubner. With the increase in the size of the lymphatic organs, glands and tonsils the swelling of the thyroid and spleen must be classed.

Other affections of the mucous membranes are the non-gonorrhoeal, seropurulent vaginal discharge and inflammatory infiltrations of the labia met with in girls and the balanitis of boys.

More important are the frequently relapsing catarrhs of the larynx and air-passages with symptoms of pseudo-croup and catarrh of the bronchial mucosa followed by non-tubercular swelling of the bronchial glands; the latter in scrofulous children may produce asthmatic symptoms.

Of similar importance are otherwise unexplained symptoms connected with the gastro-intestinal canal (dyspepsia, anorexia, oral fetor, periodic vomiting, attacks of mucous endocolitis, habitual constipation), and as a result of these conditions swelling of the mesenteric glands.

Changes in the periosteum, bones and joints very soon assume the characters of local tuberculosis. In individual cases it is usually impossible to decide whether the chronic inflammatory changes were at first scrofulous, or were tubercular from the commencement.

The most frequent general symptoms of scrofula are as follows: Alterations of nutrition, arrested growth, amyloid disease, occasional fever, secondary anaemia and lymphocytosis. The last consists of a very marked increase in the large lymphocytes, the amount of which runs parallel with swelling of the glands, and distinctly diminishes as the scrofula improves. Implication of the nervous system is shown by enuresis, night terrors, migraine, and also by a distinct pallor of the skin and mucous membranes, which is not due to anaemia.

Scrofula is a very frequent disease of children; it attacks females more often than males. The torpid form occurs particularly between 1 and 3 years, while the erythritic form is met more often in the first school ages and not rarely lasts over the period of puberty. Scrofula runs the course typical of a chronic disease. Cases are often seen in which it lasts from the first years of life to puberty, and then results in complete recovery. The torpid

form usually runs a favourable course; not so the erythritic form, which tends to frequent relapsing catarrh of the air-passages and after a shorter or longer time to pulmonary tuberculosis.

Diagnosis. Monti distinguishes three stages of scrofula; but this rather makes the diagnosis more difficult than easier. We recommend that a picture of the disease as a clinical entity should be borne in mind, and the characteristic symptomatology recognized in the vulnerability of all the tissues, in the catarrhal and eczematous changes in the mucous membranes and skin and the inflammatory hyperplastic changes in the lymphatic system, in the obstinacy of the condition and its ebb and flow, in its tendency to relapse without cause and in the multiplicity and combination of the local foci. It is of importance for the diagnosis, whether the parents in their youth suffered from scrofula or tuberculosis. There will then be usually no difficulty in the diagnosis, or only in the distinction between the exudative diathesis and lymphatism. The cutaneous, percutaneous and subcutaneous tuberculin tests can also be used, but the conjunctival test for scrofula in young children is strongly contra-indicated.

The differential diagnosis must be made from leukæmic and pseudo-leukæmic swellings of the jugular glands, which are not adherent to the skin, have no peri-adenitic infiltration and do not swell and become painful with tuberculin. Also leukaemia can be distinguished by the blood examination. Secondary diseases of the regional glands are distinguished from primary scrofulous glandular tumours by the fact that they either rapidly subside with the condition which causes them, or, if they suppurate, form a simple abscess, which quickly heals.

Scrofulous eye diseases are recognizable by the nodular deposit in the conjunctival limbus and cornea. They begin with a conical efflorescence; at the apex of the cone ulcers form, and quickly heal, often in eight to fourteen days; but very frequently return, sometimes in the same, sometimes in the other, eye. Pterygiales of the cornea heal with or without opacities, according to the depth of the ulcer; the formation of pannus is rare. In all cases the characteristic points are the nodular, not diffuse, commencement in the outer part of the eye and the tendency to relapse with the production of chronic inflammation of the lids and neighbouring skin.

The decision whether otitis media is scrofulous, tubercular, or due to some other cause is not usually possible. Often the presence of eczema and changes in the eye and the nose, accompanied by photophobia and chronic snuffling point to the scrofulous origin.

The diagnosis between scrofula and congenital syphilis may be particularly difficult. In favour of syphilis are eruptions on the skin in the neighbourhood of the glabella, the eyebrows and the chin, the presence of condylomata and radial scars in the mucous membranes, the localization of bone disease between the diaphysis and the epiphyseal cartilage and in the skull and nose, very scanty growth of hair, absence of the eyelashes, brittle, thick nails and multiple but slight swelling of certain groups of glands. The results of treatment will also afford indications.

Prognosis.

The prognosis of scrofula is generally good, but less so if caseation of the glands has commenced. The scrofulous eye changes leave behind no, or only slight, permanent injury to sight, but very rarely they may cause blindness.

Monti's statistics of scrofulous cases show that 70 per cent. recover and only 3 per cent. die. But if it attacks children, who are in a very bad state of nutrition and who are living under very unhygienic conditions, the danger of the superincumbence of tuberculosis is increased, especially if there is much exposure to infection. Also intercurrent diseases, such as inflammation of the lungs, catarrh of the bowels, anaemia, rickets, &c., relatively frequently terminate fatally, as do acute infectious diseases (measles, scarlet fever, whooping cough, diphtheria), to which scrofulous children offer little resistance. It has been remarked that measles and whooping cough very frequently transform a latent tuberculosis into the florid type.

Treatment.

In the treatment of scrofula the hygienic factors must take the first place. Often the removal from confined, damp, dark dwellings and from tubercular infected surroundings will be sufficient by itself to produce a marked change in the children. Among the poorer classes it is very desirable that scrofulous children should be removed for some time to healthy convalescent homes.

The second place is taken by dietetics, particularly when dealing with exudative conditions. On account of the intolerance the children have of fats, especially that contained in milk, all forms of fatty food must be avoided. The supersensitiveness to milk fat even in sucklings may require a reduction of the fats in the mother's diet, a diminution of the number of feeding times and a partial replacement of the mother's milk by artificial food poor in fats and rich in carbohydrates. From the first year onwards the daily amount of milk must be limited to a pint. Its place must be taken by carbohydrates in the form of fresh, green vegetables, potatoes, white bread, rice, fresh fruit and some meat,

while eggs taken regularly are unsuitable on account of the amount of fat in the yolk; the amount of butter must also be diminished as far as possible. The importance of this form of dietary in scrofula is considerable and has only recently been recognized.

The physical factors in the treatment should include proper air, light, water and exercises. Also gymnastics, massage and electricity may occasionally be employed with good results. The physical treatment promotes the activity of the skin, regulates the circulation, increases the power of the respiratory muscles and the heart, hardens the system and accelerates nutritional changes. But it is necessary that this treatment should be regulated, especially the hydrotherapeutic measures. In cases of erythritic scrofula and weakly anæmic children one can begin with dry friction of the body (once or twice a day for ten to twenty minutes), proceeding after several weeks or months to tepid sponging, and only cure slowly after the general condition has considerably improved using cold frictions. These measures should result in improved circulation of the skin, increased appetite and better temper.

Equal care is required in ordering salt baths. The salt baths can be made with common salt or sea salt (1 to 2 lb. in 12 gallons of water at 33° C. for quarter to half an hour). Specialists in diseases of children assert that in general too much use is made of baths. The fact is that under-nourished, erythritic, scrofulous children derive no good from baths, but rather harm, while fat, puffy cases are promptly influenced for the better.

To a large extent the general treatment of scrofula is that of tuberculosis of children; therefore it is best carried out in special sanatoriums, where it can be combined with suitable discipline and education.

The climatic treatment, for which the resorts on the North Sea are particularly suitable, and sea baths are mentioned in the next chapter. Here we need only refer to the sovereign effects of the sea in scrofula by quoting Baginsky's opinion, that after centuries of experience with many thousands of children there are no measures known nearly as efficacious as the sea, "which in its general effects has specific and incomparable properties."

Inunction treatment may also be used, especially if salt baths seem to be not yet applicable; its method of use is given in the next chapter.

Of internal remedies cod-liver oil has long enjoyed a special reputation; but it must only be given in the cooler months of the year and in the absence of fever and diarrhoea. If the

pure oil cannot be taken, one of the numerous preparations containing it may be tried. Iron (syrup. ferri. iodid.), iodine and creosote may also be given. Guaiacol carbonate (2 to 5 gr. several times a day) alone or in cod-liver oil, creosotal (6 to 8 drops several times a day) and sitolin may also be ordered; but none of these remedies have much effect alone. For accelerating nutritional changes the internal use of chloride of sodium has been warmly recommended; the natural salt springs may be imitated by a combination of sod. chloride 20, sod. bicarb. 30, sod. sulphate 50 parts (15 gr. in half a pint of warm water).

Systematic tuberculin treatment is indicated if the tuberculin test is clearly positive, showing the presence of a tubercular element. We recommend the use of either Koch's old, or the albumose free preparation in afebrile cases, beginning with the smallest dose (.001 c.c.m.), which must be slowly and carefully increased; more than 1 to 10 c.c.m. should not be used; if necessary the treatment may be repeated after a pause. By careful specific treatment, with which harm can be never done, the whole constitution of the child will be made more resistant to scrofulous and tubercular influences. Salge noticed a marked improvement in the local scrofulous condition and the general state ending in complete recovery. The striking effect of tuberculin in scrofula has also been observed in the Cologne clinic for children (Dautwitz). The result of the tuberculin treatment at the Berlin University clinic for children in all scrofulous children, especially those which gave a strong v. Pirquet's reaction, showed, too, a disappearance of the external signs of scrofula (phlyctenulae, skin tuberculides), increase in the appetite, increase in weight, and improvement of the general condition.

The local treatment of scrofulous affections of the skin and mucosae are important. Small patches of eczema may be treated with ung. hydrarg. previp. Large areas of eczema of a seborrhoeic nature on the face and head must first be cleansed with oil, and then treated with zinc paste (zinc oxid., amyl. aa 25, vaseline ad 100), or, if necessary, the affected areas may be painted with 10 to 20 per cent. silver nitrate solution. Washing with water or any form of soap must be interdicted. If ulcers already exist, an ointment of argent. nitrat. .1 to .2, balsam peruv. 1 to 2, vaseline 20 parts may be used.

For the affections of the eye (phlyctenula) yellow oxide of mercury or insufflations of calomel are used; if there is a suspicion of septic infection of the conjunctiva, it must repeatedly be cleansed with drops of zinc sulphate ($\frac{1}{2}$ per cent.). Recent corneal infiltrations and advancing ulcerations are to be first met

with drops of atropine and lukewarm compresses (several times a day for one to two hours). Bandages are better not employed, except when deep ulcers of the cornea are present, and then only when ordered by specialists.

Affections of the nasal mucous membrane, which generally start in the eye and relapse frequently, may be treated by washing out the nose with 2 per cent. salt solution, or if the secretion is copious and foetid boracic acid or tincture of myrrh may be added, and iodoiodol (1 to 20 parts of starch) insufflated. Ulcers and numerous crusts are best treated with ung. hydrarg. precip., the crusts must be removed, and the ointment then laid on thickly. In ozana irrigation is necessary to remove the crusts and secretion, we have had good results from $\frac{1}{2}$ to 2 per cent. guaiac-sanol solution. Turban recommends that after the irrigation a snuff of iodo, tannic acid and borax aa should be used, at first five to six times, later three times a day.

The glandular tumours are best treated by conservative measures, since the loss of blood entailed by operative treatment is very bad for the patient, and there is also a danger of setting up military tuberculosis or meningitis. Only in softened glands with abscess formation, in very large swellings and those causing severe pressure symptoms are surgical measures indicated. With suppurating glands, which are nearly breaking through the skin, an attempt may be first made according to Calot by repeated punctures and compression bandages to produce a better cosmetic result than by operation. The outward application of iodine (sod. hydoiod. 2, lanolin 50, or iodoi. pur. 3, lanolin 50), and of ung. potas. iodoi and iothiob-lanolin ointment is of service.

The treatment of periosteal, bone and joint affections must follow conservative lines. Here it must not be forgotten that scrofula is essentially a constitutional abnormality, and that an improvement in the constitution must be the first aim of all treatment. This must chiefly be sought by removal from unhygienic surroundings, by regulating the diet and nutrition, by hardening the patient, and by preventing all forms of infection.

The outlines given of the constitutional treatment show what is required for the prevention of scrofula. The prophylaxis of the secondary, tubercular component of the scrofulous condition is considered in the next chapter:

Prophylaxis.

CHAPTER XV.

Tuberculosis in Children.

Origin and Course.

That tuberculosis in children must be carefully considered in relation to the efforts being made to check the progress of the disease in general, is shown by the results of *post-mortem* examination and the experience of the cutaneous tuberculin test. We know that the frequency of tuberculosis in the dead body rises from about 15 per cent. in the first year of life, to 70 per cent. between the 11th and 12th years, that fatal tuberculosis augments in frequency with increasing age, and that even from 7 years old and onwards healed tuberculosis with cicatrization and calcification is found. Also it is known that the frequency of tuberculosis as a complication in those dying from other causes rises from 2 per cent. in the first year, to over 50 per cent. between the 11th and 14th years, that non-fatal tuberculosis becomes more common with increasing age, and that of the poorer population of large towns, who reach the age of puberty, up to 94 per cent. are infected with tubercle.

From the facts the very important inference can be drawn, that tuberculosis is a children's disease. In infancy it is certainly rare among those that are apparently healthy, but increases rapidly as the age progresses; it lessens after the age of 7 its tendency to generalization, thanks to the increasing powers of resistance of the organism, and runs a more chronic course or even becomes healed.

With the question of the origin of the tuberculosis of childhood must be considered congenital tuberculosis, in which the tubercular changes already occur before birth, and hereditary tuberculosis, which results from the transference of the virus in the sperm from the male, or more frequently during intrauterine life from the mother, the organic changes, however, only appearing during extrauterine existence. However, in far the greatest number of cases of tuberculosis of childhood the infection was

contracted from outside after birth. Tuberculosis of the parent firstly acts by producing infection in the family, and secondly by producing an hereditary predisposition, i.e., an increased sensitiveness to external infection. In the same way in scrofula there is the same inborn predisposition for tuberculosis, which by many weakening influences (underfeeding, defective hygiene, children's diseases, especially measles) is raised into an acquired increased sensitiveness to tuberculosis.

With regard to the tubercle bacilli themselves there can be no doubt that the infection with the bovine type may be dangerous for children, and that the conditions for resisting the infection are the weaker the younger the child is. But the chief source of infection for the child remains the human type of bacilli. This is undoubtedly proved by the experiments of Gaffky and Rothe at the Berlin Institute for Infectious Diseases, who by the inoculation of mesenteric and bronchial glands of 400 children on guinea-pigs found that in seventy-eight cases a tubercular infection was produced, in seventy-six of which a pure culture was obtained, being in seventy-five cases (98.7 per cent.) of the human, and in only one of the bovine type. Thus Koch's view is completely confirmed, that the risk of bovine infection in children is considerably less than the danger of infection with human bacilli.

The channels by which the bacilli enter the child's body are known, only their relative importance is undecided. Certainly aerogenous infection plays an important part in children, but especially in infants and young children a less frequent one than intestinal or alimentary infection. This appears to be contradicted by the fact that in the above-mentioned seventy-eight cases in forty-two both groups of glands were affected, in fourteen only the mesenteric, and in twenty-two only the bronchial glands; the bronchial glands were thus affected oftener than the mesenteric. But this may be explained by the fact that in children the bacilli may enter by the digestive apparatus, while the first localization of tuberculosis appears in the glands of the respiratory organs. This may occur from human bacilli, which have entered the mouth, being either carried directly to the bronchial glands through the lymphatics, or reaching with the food the digestive apparatus may pass through the intestine and the regional lymphatic glands into the lymph-stream, by which they are carried to the bronchial glands, setting up here a primary disease, which may later spread either through the blood-stream or lymphatics. In any case the tuberculosis of children in an increasing frequency according to the age of the child is set up

by the entrance into the respiratory and digestive tract of tubercle bacilli derived from plithisical cases.

The course of tuberculosis in childhood shows characteristic deviations from that in adults. This is due to the fact that the child's organism has less power of resisting the same infection. Apart from the increased susceptibility to contagion in childhood the tissues of the child have less powers of reacting to the disease, and thus localizing, encapsulating, and overcoming it. It is this failure of reaction which explains the difference of the symptoms in children compared with adults (Engel).

The forms of tuberculosis are also different at the various ages of childhood, that of infancy not being the same as in older children. The reason for this, according to the researches of Römer, is that the organism on becoming infected with tuberculosis undergoes a marked change, which makes it more resistant to fresh infections with tubercle bacilli. The normally virgin soil of the tissues of infants reacts quite differently to a tubercular infection than the organism of older children, which has already generally been attacked by tubercle bacilli. The first standing unprotected, without specific material for defence, to a severe infection succumbs with acute or generalized tuberculosis. An infection, which has not proved fatal, gives, however, to the child a certain amount of immunity against fresh tubercular infection at a later time, so that a small number of tubercle bacilli are without effect on the protected organism, whilst a severe reinfection leads to chronic pulmonary tuberculosis. Thus the development and cause of tuberculosis depends not only on the quantity of the bacilli, but also on the question whether the organism has previously been infected or not. By recent researches on immunity and tuberculosis the view of Römer has been completely confirmed, and the peril of infection for children who have still no specific protection against tuberculosis deserves much more attention than it has hitherto received.

Pathology. The tuberculosis of children spreads by the lymphatic system. It begins in the lymphatic glands, and upon the reaction of these glands depends chiefly its further development.

In infancy the lymphatic system is the part which has relatively the greatest powers of resistance. In spite of this it is not capable of withstanding the assaults of the tubercle bacilli; the tissue reaction is insufficient, and the glands fail to arrest the bacilli, which spread through the lymphatic system, attack other tissues, and without producing the characteristic local changes, constantly in infants cause a rapid, fatal ending.

In older children the power of the lymphatic glands increases with the general resistance. The glands are better able to deal with the tubercle bacilli, and to shut off the infection from the rest of the body temporarily or permanently; also the extent of the disease in the glands is slighter. It leads to the occult or latent tuberculosis of childhood, affecting especially the bronchial glands; which latent tuberculosis as a result of traumatism and infectious disease may set up acute phthisis, meningitis, or tuberculosis. This is possible because the occult tuberculosis in spite of its latency is active, the foci in the glands being recent, caseous, and not sufficiently encapsuled occasionally flare up and infect the whole body or individual organs.

About the school age the resistance of the tissues still further slowly increases. As evidence of this we find that the bacilli are arrested in certain organs, which by their nature or growth are particularly liable to tuberculosis, such as the lungs, the bones, and the joints. Thus is explained the typical secondary tuberculosis of mid-childhood.

About the time of puberty appears a certain general power of withstanding tuberculosis, which limits the importance of the glands, which no longer play the chief part. The earlier occult foci are rendered inactive by calcification, and new infections follow the same course as in adults, that is, attack directly the organ most predisposed, namely, the lungs. But as these have not yet acquired the same power of resistance as in adults, acute, progressive pulmonary disease is more common.

If we consider the pathology of tuberculosis of childhood in this way, the various differences in the course of the disease in children and adults will be understood. The lymphatic glands, especially the bronchial glands, are shown as the true centres of infantile tuberculosis, from which the diseases may spread in various ways; either by continuity to the neighbouring lung tissue (periglandular caseous pneumonia), or by the lymphatics to various parts of the lung (lymphogenic tubercular peribronchitis), or to a more distant part (mesenteric glands, bones and joints). A caseous, softened focus in a gland may also break into a bronchus, the œsophagus, or the blood-stream; in the first case by aspiration a caseous pneumonia is produced, in the second an infection of the intestinal canal may be caused, and from the third there are two possibilities: either the infective material enters an artery of the lung and sets up disseminated pulmonary tuberculosis, or entering a vessel going to the heart (vein, thoracic duct) generalized military tuberculosis is thereby caused. In the following description only the forms of disease are described,

which differ from those met in adults, and are of practical importance.

Diagnosis and Clinical Forms.

The diagnosis in children does not differ greatly from that in adults. There are a few general points which deserve attention. Firstly, the history or anamnesis is of particular importance, as showing if the child comes from a tubercular milieu. In the physical examination enlargement of the glands must be especially sought for. Percussion of the thorax must be done very lightly, but by finger to finger. The results of auscultation must be very critically examined, and the normal, increased, or puerile breathing must be remembered. The bacteriological examination in children is very unreliable, but the Röntgen-rays give clearer and more unequivocal results than in adults.

Whilst the serological methods are all of doubtful value, the specific tuberculin tests, especially the cutaneous inoculation of *v. Pirquet*, are for children the method of choice. A positive result usually indicates tuberculosis, and a negative is with the greatest probability against it; the younger the child the more certain the result, so that in the first years of life a negative test excludes tuberculosis, while a positive result shows that the disease is active. In somewhat older children, and in cases in which the *v. Pirquet* reaction is not suitable, the intracutaneous injection of tuberculin is recommended; its technique is rather more difficult, but its results are more trustworthy. The conjunctival test is strongly contra-indicated in children. The older the child is, the more necessary becomes the original subcutaneous tuberculin injection of Koch. Its use has been described earlier, but in children half the larger doses suffice (i.e. .5, 2.5, and 5 c.mm.). The focal reaction is of more importance than the local tests and needle reaction recommended by Escherich.

Tuberculosis of Infancy.

In the tuberculosis of infancy the most constant clinical symptoms are produced by the disease of the bronchial glands, which is usually primary. Secondary foci may appear in the lungs, leading to infiltration, but their appearance in infancy is rare. According to Eitlinger post-mortem examinations give the following figures for the tuberculosis of infancy: lungs, liver, and spleen are affected in 100 per cent., kidneys in 94.8 per cent., bronchial glands 84.6 per cent., intestinal tract 65.8 per cent., mesenteric glands 34.2 per cent., pleura 21 per cent., brain and pia mater 18.5 per cent., larynx and pericardium 5.5 per cent. Even in infants a few weeks old there have been seen tubercles, phlyctenulae, and bone tuberculosis; the appearance of

tuberculosis of the skin in infants infected with tuberculosis is very common. The course is often very acute, and the more so the younger the child at the time of infection; sometimes it lasts a few months. Even in the first half year of life the prognosis is not absolutely black, if the infection is slight. It depends, apart from the age of the patient, on the clinical course and localization of the disease. Young children with adrebrile tuberculosis of the glands, bones, or joints not infrequently live, while if an internal organ, especially the lung, is affected, they always die. According to Pollak the mortality in the first half-year is 86 per cent., and 59 per cent. in the second. The severity of the infection of infants seems to depend on the severity of the disease in the infecting person; also the quantity and virulence of the bacilli play an important part. There is a form of latent tuberculosis of infancy; it is therefore advisable, in cases in which the infant without obvious cause becomes pale and badly nourished in spite of suitable food, to employ *v. Pirquet's* test. The local symptoms are not usually distinct. When the lung is diseased cough and expectoration are absent, the breathing is superficial and accelerated, the pulse small and frequent, the temperature atypical, often subnormal, and death occurs with the characteristics of atrophy. In those infants who live through the first year the tubercular habitus is developed; it is therefore the consequence of an already existing infection.

Bronchial Glands.

Up to about the age of 12 tuberculosis of the bronchial glands takes the place of the apical disease of adults; when tuberculosis occurs in a child, it is usually present. Tuberculosis of the tracheo-bronchial and bronchopulmonary glands, with which the mesenteric glands are often involved, produces caseous or calcified swellings of the size of a walnut or larger. With the Röntgen-rays the calcified glands appear as foreign bodies of the shape of a projectile, and the caseous glands as less sharply defined shadows, the most swollen ones being generally impossible to recognize. There is as yet no agreement about the interpretation of shadows about the hilus; but there is no doubt that for the diagnosis of disease of the bronchial glands the Röntgen-rays give the most information. The hilus shadow may be considered to be pathological if it is abnormally dark, broad, and contains an excessive number of shadow spots; more circumscribed, dense shadows indicate with certainty enlarged and diseased glands. Also in the hilus, tuberculosis of children, more frequently on the right than the left side, shadows may be seen, which join the main bronchus and the cardiac dulness, and from there spread

more or less irregularly into the middle of the lung areas; they are generally horizontal, more rarely run upwards or downwards; they indicate an extension of the disease from the lymphatic glands into the lung tissue in the neighbourhood of the hilus (Shuka). It is best to employ oblique illumination for the tracheal glands, and ventrodorsal illumination for the hilus of the lung.

The most active symptoms of tuberculosis of the bronchial glands are limited, apart from infants, as a rule to the first years of life.

Besides the unreliable signs afforded by the appearance and state of nutrition of the child the temperature, the pulse, the papillary and ocular changes (sluggish reaction, exophthalmos, Graefe's and Stellwag's signs), and the changes in the digestion and appetite, the more constant signs produced by bronchial gland tuberculosis are Petruschky's spinalgia, tenderness on pressure over the spines of the first to eighth dorsal vertebra, and circumscribed dullness at the side of the manubrium sterni and the sternoclavicular articulation with paravertebral dullness at the side of the second to fifth dorsal spines. Over the dull areas there are bronchophony, increased fremitus, altered breath sounds, and not rarely very loud tracheal breathing and stenotic murmurs. Dautwiz considers that bronchophony with the whispering voice is the surest sign.

Also Korányi's vertebral percussion and auscultation of the whispering voice over the vertebrae are useful in detecting enlarged bronchial glands. According to the exact observations of Michaelowicz in tracheobronchial tuberculosis of children there is dullness over the first to fifth thoracic vertebra; the dullness over the first four vertebrae is due to the tracheal glands, while that over the fourth and fifth (in older children also the sixth) is due to enlarged glands about the bifurcation of the trachea. Auscultation over the vertebral column reveals increased loudness of breath sounds with bronchophony (D'Espine's symptom).

Very characteristic is a croupy, whistling cough of a very high note (bronchial gland cough) and particularly expiratory dyspnoea and expiratory râles. In the first years of life this is increased into an expiratory wheezing, which can be heard at a distance. It is the result of compression of the main bronchus, usually the right, in the short extent between the bifurcation and point of origin of the bronchus to the upper lobe.

Less typical is a spasmodic cough like whooping cough, caused by pressure on the vagus and its branches. In such cases the diagnosis between whooping cough and tuberculosis of the

bronchial glands may be difficult. The latter is indicated by the tuberculo appearance, which in the earliest years is shown by wasting, the paralytic thorax, fine, dry skin, lanugo between the shoulder-blades, on the forearm, the legs, and temples, a deep blue iris with a dark ring, and the frequent combination of blonde hair with long dark eyelashes.

The differential diagnosis has also to be made from asthma, adenoids, capillary bronchitis, and diphtheritic laryngeal paresis. Besides the Röntgen-rays in all cases the specific diagnosis, especially *v. Pirquet's* test, is important. Since in the first years of life the disease in the bronchial glands is constantly primary and always active, the result of the cutaneous test taken in conjunction with the clinical evidence gives sufficient information as to the site and character of the disease. Only in older children the subcutaneous test cannot usually be dispensed with; focal reactions in the bronchial glands are shown by increased cough, pains between the shoulder-blades, feeling of increased fullness in the chest and intense pain on percussion between the shoulder-blades.

The prognosis of tuberculosis of the bronchial glands is the better the greater the age of the child at the time of infection; after the second year it is relatively favourable. But even older children run a danger of sudden generalization of tuberculosis, which is a sufficient reason for carefully examining the bronchial glands.

Mesenteric Glands.

Tuberculosis of the mesenteric glands in childhood has the same importance for the digestive organs as bronchial gland tuberculosis has for the lungs. On account of the permeability of the infant's intestine to the tubercle bacillus, the disease in the mesenteric glands may be primary; though isolated tuberculosis of the mesenteric glands is on the whole rare. More commonly they are secondarily affected from disease in the cæcum, the lower ileum and the peritoneum. The diagnosis may be difficult, since the glands can only be palpated when they are large. It has been thought that, as a sign of mesenteric gland tuberculosis in children, the localized glandular tumours in the mesentery of the small bowel could be recognized without operation; but it is not so. If there is no inflammatory reaction around them, their clinical recognition is even more uncertain than in adults. If a tubercular history cannot be obtained, then the diagnosis will not be usually possible until continuous pains, often in paroxysms, with wasting, pallor and slight fever appear. If the mesenteric gland tuberculosis is the most prominent part

of the clinical picture, *tuberc. mesenterica* is spoken of. Suppuration of the glands followed by rupture into the peritoneum is very rare.

External Glands.

Tuberculosis of the external glands is a more favourable type of disease. The cervical, supraclavicular, extrathoracic, axillary, and inguinal glands are affected in the order given. In older children several of these groups may be affected at the same time, or the bronchial and mesenteric glands may also be infected; but general lymphatic gland tuberculosis is limited to the first three years of life. In children with any form of tuberculosis the regional lymphatic glands are very frequently affected. But such glandular swellings should only be considered to be tubercular, if the primary disease can be demonstrated and if the regional glands surpass in size and amount of disease the other swollen glands.

Care is needed in ascribing swelling of the cervical glands to tuberculosis, since in children non-tubercular disease of the mouth and pharynx, leading to simple swelling of the regional glands, is common. Glandular tumours are also met in scrofula, leukaemia and Hodgkin's disease. The axillary and inguinal glands are very frequently swollen in non-tubercular children, but marked swelling of the supraclavicular and extrathoracic glands indicate with more certainty tuberculosis of the pleura and lung. The tuberculin test is often indispensable. The specific focal reaction is shown by swelling and pains. The prognosis is good on the whole, since the glands, if they soften and discharge, free themselves from the infective material.

Lungs.

Tuberculosis of the lungs occurs quite frequently after the tenth year; it usually starts at the apex and spreads uniformly over both lungs. The diagnosis may be difficult, as a comparison with a sound lung is not possible. Marked induration and cavities do not form.

In small children the disease in the lungs is usually secondary to the bronchial glands. The lower lobe is first affected, the pleura and pericardium often become infected. The apex often remains free. K. E. Ranke describes tuberculosis of lymphatic glands in the lung as particularly characteristic in the earliest years. It is a severe form, which appears chiefly in the first two years, and is marked by diffuse affection of the lymphatic tissue of the lung with relative freedom of the parenchyma. It is accompanied by diffuse bronchitis, which being a reaction of the lung to the bacillary infection is the more marked the acuter is

the tubercular lung disease. So long as the process remains limited to the lymphatic glands of the lung, only the bronchitis can be detected on physical examination; the extrapulmonary glands are constantly enlarged, especially those in the neck and the side of the chest.

That the generalized tuberculosis of the lymphatic glands of the lung described by Ranke occurs is undoubted, but it is often nothing else than a miliary tuberculosis of the lungs, spreading only through the lymphatics. The tendency to acute and rapid spread through the lymphatics is pathognomonic of phthisis in children. Therefore acute miliary tuberculosis of the lung and subacute caseous pneumonia occur in children more often than in adults.

Acute miliary tuberculosis of the lung is difficult to diagnose, if the course of the disease has not been followed from the commencement. The primary focus in the lung, from which the acute disease originates, becomes masked by acute bronchitic signs. Tubercle bacilli cannot be discovered. We are therefore driven to rely on the general toxic symptoms. Atypical high fever (up to 103.5° F.), very frequent pulse (180), accelerated, dyspnoic respirations (40 to 60), stupor, rapid wasting, enlargement of the spleen, and petechiæ of the abdomen indicate the gravity of the disease, while the signs in the lung are negative or simply point to a general diffuse bronchitis, which is only excluded by the severity of the general condition. The cutaneous test is allowable, but unreliable here; the subcutaneous test is contra-indicated. The prognosis is absolutely bad.

Caseous pneumonia in children is easier to diagnose. With severe general disturbance catarrhal symptoms appear with cough, expectoration, shortness of breath and pain in the chest. The physical signs indicate inflammation in the smaller bronchial tubes, increasing infiltration, breaking down and destruction of the parenchyma of the lung. The cough becomes more violent and distressing, the sputum copious and purulent, but tubercle bacilli almost without exception cannot be discovered. At the same time night sweats, hectic fever swinging from 94° to 104° F., vomiting, diarrhoea, progressive emaciation and atrophy, make their appearance. If meningitis or cardiac weakness do not cause death rapidly, the child dies from carbonic acid poisoning caused by respiratory insufficiency. Transudation into the peritoneum, œdema of the lower extremities and obliterative thrombosis are terminal symptoms. In older children the disease may rarely become arrested, a growth of connective tissue, contraction and the formation of bronchiectasis taking place as in adults.

In these cases fever and cyanosis may diminish, but the low state of nutrition does not improve, the cough, dyspnea and night sweats continue, the tubercular appearance remains, and in spite of the apparent improvement sudden death may occur without obvious cause, or at times with meningeal symptoms. The prognosis is absolutely bad, in spite of all treatment.

The differential diagnosis must be made from the capillary bronchitis and broncho-pneumonia of children. The marked malnutrition, the hectic temperature, the respiratory insufficiency and the destructive lung changes should settle any doubt. The cutaneous tuberculin test can also be applied, but the subcutaneous method is excluded by the fever.

Pleurisy. Tubercular pleurisy in childhood is particularly difficult to diagnose, especially

from pneumonia. The auscultation signs alone are in many cases not distinctive, since, contrary to the rule, the breath sounds in pneumonia may be weakened from obstruction to the bronchus, and in pleurisy may be loud and bronchial; the latter is particularly the case in sacculated empyema and very large effusions. On percussion it is very often found in small children that in cases of pleurisy the whole of one side is dull, while pneumonic infiltration usually only affects one lobe, and disease of the lower lobe does not extend further than the anterior axillary line. Therefore extension of the dullness over the whole of one side or in front of the anterior axillary line indicates pleurisy, even if loud bronchial breathing conducted from the lung compressed against the trachea and bronchus is heard over it. The intensity of the dullness gives no certain information, neither does paravertebral dullness on the sound side, nor paravertebral resonance on the affected side, nor the state of the vocal fremitus, which in children is difficult to examine. Serous pleurisy in children is usually of tubercular origin; the exudation then contains a larger number of mononuclear leucocytes, and, as Hamburger has lately emphasized, and as our own experience shows, never becomes purulent. "Thoracic empyema is never of a tubercular nature," in contrast with pyopneumothorax, which in both adults and children is nearly always tubercular. In non-tubercular serous effusions the polymuclear leucocytes preponderate. The course of the fever, the way the disease commences, the general condition and the history do not always decide the question whether there is a tubercular serous effusion or a non-tubercular purulent one; a chronic empyema may be very easily mistaken for tuberculosis. In such doubtful cases a puncture must be made with a needle of not too small a bore.

Miliary Tuberculosis.

Miliary tuberculosis at the commencement is very difficult to diagnose in children. Its distinction, for example, from a central group pneumonia may be impossible. For such cases Hamburger recommends the use of the cutaneous tuberculin test. It is true that in miliary tuberculosis the child's sensitiveness to tuberculin is considerably decreased, but it does not disappear altogether. The result is that only a very weak reaction appears, consisting of redness, but no, or only slight, exudation at the site of inoculation. Failing the cutaneous test, the needle-track method of Escherich may give a correspondingly weak reaction, 1 increasing to 1 c.mm. of tuberculin being used. Redness without infiltration in the needle track is thereby produced. We consider that both tests are not sufficiently reliable, and that the latter may be even dangerous.

Meningitis.

Tubercular meningitis is the most common cause of death in children from 1 to 4 years old; to sixty such cases in children there are only eight in adults. This is no doubt due to the large amount of plasma, the increased nutrition and the copious blood supply in the rapidly growing brain of earliest years of life.

The diagnosis in children, thanks to a distinct regularity in the course of the disease, is usually easier than in adults. In childhood it usually begins with cerebral symptoms, without tubercular disease in any other organ having become evident. The child, therefore, appears to have been previously healthy, only—a fact well worth noticing—the temperament having become more dull, peevish and self-centred. Suddenly violent cerebral vomiting, without nausea and unconnected with taking food, appears; high fever and other objective symptoms are still absent. If the vomiting is accompanied by constipation, the probability of meningitis will be increased; though diarrhoea does not exclude meningitis. Heubner considers it noteworthy that in children during the second week of the disease with marked slowing of the pulse there is also a fall in the temperature and respiration rate, so that in the three curves of respiration, temperature and pulse there is a fairly regular saddle-shaped depression.

As the disease advances the effects of increased intracranial pressure appear; in children the paralytic symptoms are usually more marked than in adults. In infants the increased size and bulging of the anterior fontanelle makes the diagnosis easier. If the onset occurs with convulsions, as it may during the first and second year, it is noteworthy that purely functional spasms

of an epileptic or tetanoid nature either produce no bulging of the fontanelle, or only during the attacks, and that persistence of the distension of the fontanelle between the attacks is indicative of meningitis. If the cranial sutures, as during the first months of life, are still yielding or open, instead of the distension of the fontanelle, there will be a separation of the bones of the skull.

Kernig's sign, *i.e.*, the incapacity to fully extend the legs while in a sitting position, cannot be looked for in infants; and Lasègue's sign, which consists of the impossibility of fully extending the legs while the patient is lying with the hips bent to a right angle, can only be relied on partially: in older children it supports the diagnosis of meningitis, but its absence has no importance.

The jerk phenomenon (*le signe de la nuque*) seems more important in children; Brudzinski found that it was absent only in one moribund patient out of forty-two cases of meningitis, while Kernig's sign in the same cases failed twenty-two times. It likewise is a reflex symptom and is obtained by moving the head of the recumbent child forwards in a jerky manner with one hand, while the other hand is placed on the chest to keep the body flat; if the sign is positive, both the knees and hips become flexed, sometimes the legs are completely drawn up on the abdomen. Not so regularly in the meningitis of children can be found the contralateral reflex also described by Brudzinski, in which if one leg is strongly flexed passively there follows a similar flexion of the other leg. The result of numerous trials of these tests is that the appearance of the reflexes is in favour of meningitis, but their absence is not against it.

In children the lumbar puncture clears up the aetiological diagnosis in most, and according to some authors in all cases. The fibrous clot which forms near the surface of the fluid removed by lumbar puncture must be very carefully examined; in cases of meningitis in children it is extremely delicate and contains in its meshes the bacilli often in large numbers, but sometimes a very few between numerous lymphocytes. In any case it is easier to find the bacilli by staining the carefully removed clot than by centrifugalizing the fluid (p. 428). Lymphocytosis of the fluid is met with in children not only in tubercular meningitis, but also congenital syphilis, and the acute stage of poliomyelitis; it seems of itself to have no aetiological significance. Mayerhofer and Sauber recommend the permanganate titration of the cerebrospinal fluid, since in tubercular meningitis the reduction power of the fluid in regard

to permanganate is very much increased even in the early stages of the disease (fourteen to sixteen days before death). The process is complicated and requires to be tried further before it can be recommended.

The differential diagnosis must be made in children from certain forms of gastro-enteritis, and from acute infectious diseases, especially pneumonia, typhus and epidemic cerebro-spinal meningitis. In all cases the cutaneous test can be tried; according to Hamburger in tubercular meningitis the same results are obtained as have already been described in military tuberculosis. Test tuberculin injections are absolutely contra-indicated.

The prognosis is very bad. Especially the cases with early convulsions and head retraction run a rapid course; somnolence, fresh convulsions and coma appear and cause death in three to four days.

Bones and Joints.

Tuberculosis of the bones and joints, owing to its frequency, has great importance in childhood. According to Billroth

a third of the cases occur during the first ten years of life. Boys are affected twice as often as girls, probably because they are more exposed to traumatic influences. Measles, whooping cough and scarlet fever have for long been considered as immediate causes. The disease of the bone is often the first manifestation of tuberculosis in the child; it may be primary, but is usually secondary to an old latent focus.

The bones most frequently affected in children are the long bones and the vertebrae.

Periostitis and osteitis often occur in children in the form of tubercular dactylitis. The relative frequency of the painlessness of the condition is remarkable. Tubercular spondylitis is particularly difficult to recognize in the early stages. Acute inflammatory changes may occur without much pain. Or the little patient may refer the pains not to the back but to the intercostal region or abdomen. "Abdominal pain with normal stools always raises the suspicion of spondylitis, and demands a careful examination of the vertebral column" (P. Lange). It is characteristic that the patient holds the spine stiffly and unasily, particularly if he wishes to pick anything up. Later the diagnosis can be made from the isolated prominence of one spine, or by the appearance of abscesses with necrosis and sequestra; the angular spine can be easily distinguished from the arched, rickety vertebral column. In all doubtful cases a good Röntgen picture should be taken.

The hip is the joint that is most frequently diseased in

children; it is affected in one-third of all cases of tuberculosis of the joints in childhood; 70 per cent. of the cases occur during the first ten years of life. Coxitis may be very difficult to recognize, if the foci have not yet broken into the joint. In the first two years they more often appear in the neck of the bone than in the epiphysis. Generally one or two enlarged lymphatic glands can be felt along the external iliac vein. Lameness, pain on movement and swelling may at first be absent. The first symptoms are often pain in the knee, and tenderness in the hip-joint on striking the sole of the extended foot. The best method of early diagnosis is by means of the Röntgen rays, which cannot generally be omitted; an atrophy of part of the bones within the joint will be shown. The direct diagnosis will become easier when the head of the femur or the acetabulum has become destroyed and the head has left the cavity. There will be then constantly a shortening of $\frac{3}{4}$ to 1 in. and adduction of the leg, and the Röntgen rays will show clearly the alteration in the joint. It should be a rule in cases where there is pain in the hip or knee to think of coxitis. The hip-joint should be tested as to function, muscular atrophy, swelling, tenderness and pain on movement, the length of both legs compared, the relation of the trochanter to Nelaton's line determined, and a Röntgen picture taken. In doubtful cases of synovial disease the subcutaneous tuberculin test may produce focal symptoms.

After the hip, the knee, foot and elbow are most often affected; in all cases the disease usually begins in the bone. These conditions produce no symptoms peculiar to children. The opinion of Poncet is worthy of notice, that the scoliosis which frequently appears between the ages of 8 to 12 is caused by tuberculosis; a weakened form of tubercular infection produces vertebral costo-malacia, which forms the starting-point of scoliosis. Similar "pretubercular" affections, according to Poncet, are also the osteo-articular deformities of youth, such as inflammatory flat-foot, genu valgum, coxa vara and radius curvus. This view, which relegates to the background the static and dynamic causes of these abnormalities, we must entirely refuse to support.

Treatment.

The treatment of tuberculosis of children, at whatever age and in whatever form it appears, must be founded on a physical and dietetic basis. This can be systematically applied, apart from infants and the youngest children, for whom all treatment is nearly hopeless, best in sanatoriums for tubercular children, which in principle do not differ from adult sanatoriums. Only the amount of the various factors

of the treatment (rest in the open air, exercise, hydrotherapeutics, diet and drugs) must be modified to suit the requirements of the child. The school and the workshop are the only fresh factors in the children's sanatorium, in which those that are slightly ill or merely convalescent can be instructed under medical supervision, that it may be easier for them later in life to find suitable employment.

The treatment of tuberculosis of children with tuberculin is of later date than the specific treatment of adults, but it has been now so well established by many workers, that there can no longer be any doubt as to its suitability under proper conditions. Tuberculin assists in bringing about recovery in cases of tubercular glands and in numerous cases of chronic tuberculosis, which can only be recognized by the toxic general symptoms and a positive result from the cutaneous test. Tuberculosis of the lungs in older children is only suitable for this treatment, when it takes the form of slight apical catarrh with but little dullness or shadow in the Röntgen photograph, or of slowly advancing induration. Slight fever and a low state of nutrition are then no contra-indication; but all acute and progressive cases of phthisis, and all the breaking down forms of lung tuberculosis of infancy should be excluded from specific treatment. It is necessary to begin with the smallest doses, which should be slowly and carefully raised till a large dose is reached. The very rapid increase in dose recommended by Schlossmann, Engel and Bauer till very large amounts are reached, is not necessary, since good results have been obtained with smaller doses. Also we cannot recommend the anaphylactic method, which consists of the repetition of the same minute dose for months. For children the immunizing method is the best, which by commencing with small doses and gradually increasing them aims at accelerating immunization by increasing the focal inflammation and the formation of antibodies. The effects, which often appear quickly, are improvement in the general condition, appetite and weight, in diminished rise of temperature, and in lessening of the cough and night sweats. These results have been confirmed in the Berlin University Children's Clinic, where the children in the early stage of pulmonary tuberculosis treated by tuberculin showed, apart from the improvement in the general condition, a diminution in the cough, pains in the chest and night sweats, while diarrhoea was replaced by normal action of the bowels.

In children as in adults the best and surest results will be obtained by a combination of sanatorium and tuberculin treatment. The sanatorium teaches the child hygiene, discipline, and

order. Whether good results can be obtained in open cases of pulmonary tuberculosis the future must decide. In open cases before the school age at present no lasting results can be expected, so that they are not suitable for sanatorium treatment, which may be tried for older children with open disease if the history, social conditions, and physical signs are favourable. Advanced chronic cases and acute progressive disease should be excluded from children's sanatoriums, as also should hopeless cases with tubercular or non-tubercular complications. In the sanatorium itself there should be a strict separation between the open and closed cases, since with children the proper hygiene of the cough and sputum is very difficult to carry out. Small institutions for children should refuse open cases on principle, larger sanatoriums should provide for isolation and proper treatment of such cases. Besides in sanatoriums children with tuberculosis may be treated in forest homes, in open-air homes, at the seaside, by salt baths, in special children's hospitals, or in special wards in general hospitals, or at home.

Forest homes in the neighbourhood of large towns give good results for older children with closed tuberculosis. There they may rest and be carefully fed through the day, returning at night to their homes. The ambulant tuberculin treatment is also well suited to such cases.

Open-air treatment may be carried out especially in the mountains with good results in the tuberculosis of children. A residence in such quiet, peaceful places is to be recommended for those children who at the seaside are tired, sleepless, or feverish.

A visit to the North Sea coast takes the first place for children with scrofula or tuberculosis of the glands and bones. The children's institutions erected by societies admit poor children, but refuse cases of open tuberculosis.

Simple salt baths and carbonic acid thermal salt baths are recommended for the treatment of glandular tuberculosis of children. They act by increasing the intake of oxygen and the excretion of carbonic acid, and thereby altering the nutrition. The salt baths are not suitable for the treatment of pulmonary tuberculosis in children, either alone or combined with the drinking of mineral waters.

Children's hospitals only, as a rule, take cases of severe chronic or acute phthisis. They cannot undertake at the same time the alleviation of those seriously ill, and the treatment of those slightly affected, until special hospitals are built for tubercular children.

The home treatment by the practitioner will be needed for

children returning home from institutions, seaside, &c., not yet completely cured, and also for the large number of cases who on account of their age or for other reasons cannot be sent away. So that the general practitioner will daily meet cases of tuberculosis in children. The treatment must include a sufficiency of rest, light, air, and sun. The body may be regularly washed or rubbed with salt water, or baths may be given with common salt, sea-salt, or prepared salt. In the feeding a large part must be played by good milk. Diluted oatmeal gruel with butter, soups, fresh green vegetables passed through a hair sieve, and eggs may all be given. In children over three years old the diet more approaches that of adults. Milk and butter, fresh green vegetables, fruits, farinaceous foods, puddings with cream, and meat juice may all be employed.

Of drugs cod-liver oil is most serviceable in its various preparations, lipanin, ossin, Scott's emulsion, malt extract, pure or with addition of calcium, iodine, or iron. The various preparations of crocodite and guaiacol are not generally of much use; thiozol and strolin can be employed. Arsenic is best entirely omitted. Kapesser's soft soap treatment deserves especial mention; about a tablespoonful of *sapo calvus* is rubbed alternately into the front and back, it is then thinned with some warm water, and removed by washing or a bath after half an hour. The rubbing may at first be done every day, then every two or three days. The skin over the affected glands must not be rubbed.

Since the localized tubercular foci in children are only slightly sensitive to tuberculin, specific treatment is very easy to carry out; and ambulant treatment for older children is therefore possible. Wherever a plentiful and suitable diet is possible, with a sufficiency of attention, light, air, and sun the practitioner has in a combination of the bath, soft soap, and tuberculin treatment an excellent weapon for attacking cases of tuberculosis in children, which are still capable of improvement, and of bringing about recovery in slight cases, perhaps after a long time.

However, the practitioner will have to deal with many cases which resist all treatment, since the *vis nature medicatrix* is exhausted. Here symptomatic measures can be only applied to the fever, loss of appetite, exhausting cough, pains, hæmorrhage, and diarrhoea, in the way that has already been described. We need here only say that narcotics (morphine, opium) must as far as possible be avoided in children, or only given to the older ones in small doses and not for long at a time. The less toxic preparations are always sufficient.

In the treatment of tuberculosis of the bones and joints of

children it must be first noted that there is usually a limited, local form of the disease with favourable prognosis. Also that operations in children entail a great danger of spreading the disease. Lastly, functionally perfect results are to be still less expected with the growing bones and joints of children than of adults. Under those circumstances general treatment and conservative measures are now recognized as being the most suited to the surgical tuberculosis of childhood.

In the first place general treatment with rest, sun, good air, and good food is absolutely necessary. Climatic influences, such as long duration of sunshine, intense sun rays, and a prolonged stay at the seaside, have a good general effect, and also a quite special local action. On the other hand, a course of salt or thermal baths with the internal use of mineral water cannot remove the tubercular disease, certainly not in four to six weeks. It is more important that children with tubercular bones and joints should have good food, and remain the whole day in the open-air, if possible out of bed; such a course of treatment must be continued for months either in the summer or the winter without regard to the season. The hygienic and dietetic measures may be aided by the sunlight treatment, which has been brought into notice by Rollier at Leysin, and Bernhard at St. Moritz, and is becoming of greater importance. The effects of the direct action of the sun's rays on the tubercular bones and joints of children are diminution of the pain, cleansing of open disease, and covering in of the ulcers. Closed tubercular foci need not be opened; the bactericidal powers of the sunlight at considerable altitudes, with the general hardening effect of the climate, penetrate so deeply, that even fungoid disease and tuberculosis of the vertebrae can be healed, with retention of the power of movement of the joint. It is therefore chiefly from the surgical side that the wish is expressed that heliotherapy may be made available in a suitable mountain resort for those with small means, at any rate for the winter months, during which sun treatment at low altitudes is not possible. In Vienna and Cologne during the summer months experiments have been made, and very good results achieved. A long stay at the seaside will also obviate a large number of operations, and produce a cure of tubercular bone disease without deformity, such as can scarcely be obtained in large hospitals.

In any case, the treatment must be as far as possible conservative. According to the abundant experience of Hoffa the mortality is about the same with conservative and operative treatments, but the final functional results in those treated con-

servatively was very much more favourable. Every operation in childhood causes more or less mutilation, and therefore the ultimate utility of the limb is often very doubtful. Resections in children on account of injury to the growth of the bone in consequence of interference with the epiphyses must be regarded very seriously.

The conservative treatment consists in keeping the affected bone or joint at absolute rest. If the joint is diseased extension may be also applied, to draw the joint surfaces apart, and by relieving the pressure put them out of use. By exactly applied plaster bandages or suitable orthopaedic apparatus the desired end is not difficult to attain. The best method of applying conservative treatment to individual cases cannot be considered here. The decision must often be made by a specialist, regard being paid both to the local and general condition. In view of the frequency of tubercular disease of the hip and knee we may emphasize the fact that resection of the hip-joint in children under 15 is now generally condemned, unless suppurating sinuses with severe secondary infection are directly endangering the patient's life; also non-suppurative disease of the knee is now better treated entirely on conservative lines; if suppuration has occurred in older children resection may be considered, and in younger ones amputation, but in both cases only if all other means, especially sun-rays, have failed, and amyloid disease is commencing. Tubercular spondylitis must be treated by orthopaedic measures, the use of which according to F. Lange "should not be left entirely to specialists, but can and must be adopted by all practitioners." As long as the disease is recent and accompanied by severe pains, the best means according to Calot is plaster of Paris, preferably in the form of a jacket, which reaches to the head, is exactly modelled, and has a window cut over the angular projection, so that the deformity can be influenced by means of increasing pressure with a pad of wadding. In no case must such a patient be left in the hands of the instrument maker, nor must spondylitis be treated with corsets. With the plaster treatment of acute cases must be joined the recumbent position, which must be maintained for months; in the French seaside institutions a lying-down treatment in a padded wooden frame is favoured, in which by means of roll cushions a straightening of the vertebral column is obtained.

The conservative treatment may be aided by injecting iodoform glycerine (10 per cent.) into the tubercular focus every eight to fourteen days. For the first injection 75 gr. of the emulsion is sufficient; if the child bears the iodoform well, i.e., without

eczema and toxic symptoms (headache, sleeplessness, peevishness, hallucinations) the next injection may be of 150 gr. For abscesses in connection with spondylitis the iodiform injections are also to be recommended. Remarks on the treatment by trypsin, Röntgen-rays, hyperæmia, &c., will be found in Chapter IX.

For the purpose of combining conservative and general treatment it is desirable that special sanatoriums should be built near large towns for cases of surgical tuberculosis of children. Such institutions have been built near Berlin, Hamburg, and Stuttgart. Tuberculin preparations are also used in them with good results. Hoffa has recommended the use of Marmorek's serum.

To recapitulate, we may say that there must be a combination of a hygienic and dietetic régime with conservative measures and specific treatment for cases of tuberculosis of the bones and joints in children.

The practitioner, who is not able to make use of these requisite factors, must send his patients where these methods can be thoroughly carried out. It is certain from the first that the duration of treatment will be long—in spondylitis one to two years, in hip disease one to one and a half, in disease of the knee half to one and a half—and it is well to enlighten the relatives as to this. In spite of the importance of the sun, the sea or the mountains, the personality and capability of the doctor, by whom the treatment must be adapted to each individual case, is of the utmost weight. A pessimistic view of tuberculosis of the bones and joints of children is only taken by those who do not discover the condition early enough, or when proper measures have not been taken to prevent irreparable local and general disturbance. The casual removal of such cases for a few weeks to some place to "convalesce" without putting them under the care of some doctor, is to be thoroughly condemned. The after-treatment may be carried out at home, if the social conditions allow it.

The awakening that is now taking place with regard to the care of cripples will have the result of making our surgical clinics, and general and children's hospitals more than hitherto into sanatoriums for cases of surgical tuberculosis of children.

Prophylaxis. The prevention of tuberculosis of children as of adults must be directed towards raising

the powers of resistance and diminishing the risks of infection. Suitable nourishment adapted to the age of the child, general care and hardening of the body, abundance of light, air and sun, sufficient rest, and plenty of exercise in the open-air increase the

resistance of the growing child to the tubercular infection, until it acquires a certain natural power of protection. With these measures are closely bound up those directed towards diminishing the risks of infection for the child.

In the first place we put the hygiene and sanitation of the dwellings, particularly those occupied by tubercular families. "The most important problem in the prophylaxis of consumption is the saving of children in phthisical homes from severe tubercular infection" (Roemer). To this end frequent disinfection of the sick-room and bedding of phthisical cases, with complete disinfection of the dwelling on change of residence or death of cases of open tuberculosis is in the first place required. In the first year of life the dwelling-house is almost the whole world for the child, and tuberculosis is specially a house disease, and dirt infection is very common in the earliest years of life. For this purpose one must continue to agitate for legal compulsion for disinfection of the homes of open tubercular cases, especially on change of residence.

More important, but also easier than the attack on already existing tuberculosis, is the "production of a race free from the disease." The prophylaxis must therefore begin in infancy. That there is a close connection between tuberculosis and infantile mortality is shown by the statistics of Hamburger and Sluka, according to which of the infants examined in the post-mortem room at Vienna 6 per cent. of those 3 months old were tubercular, 17 per cent. of those between 3 and 6 months, and 22 per cent. of those between 6 and 12 months, and taking all those dying in the first year together 16 per cent. showed signs of tuberculosis. Therefore measures must be taken against infant mortality at the same time as against tuberculosis of childhood. It is perhaps more important to encourage healthy mothers to suckle their children than to forbid tubercular women from doing so, since a breast-fed child is more resistant to all infections, including tuberculosis, while a bottle-fed child in a tubercular milieu is a certain victim for tuberculosis.

It is the duty of the public health officials to look carefully into the supply of milk, and to see that it is free from bacilli, so that it can be taken in an uncooked state by children without danger. That action is necessary is shown by the observation of Schütz that in 1907 of the cattle slaughtered in Germany 21 per cent. were tubercular, and also by the fact that about 10 per cent. of tubercular children have primary foci in the intestine. It is generally agreed that the prevention of the contamination of milk with bovine bacilli would reduce the number of cases of tubercu-

leas of the abdominal organs and cervical glands in children. Measures must be directed against the spread of tuberculosis in cattle, and the sale of the milk from a cow known to be tubercular must be prevented, whether the disease is situated in the udder or elsewhere. There still exist differences of opinion as to the diagnostic measures to be employed in excluding the milk from certain cows. Some hold that a general examination of the cows and an occasional bacteriological examination of the milk are sufficient, while others think that these methods are only reliable when combined with the tuberculin test for cows, whose milk is intended for children. It seems to us to be impracticable and going too far to exclude entirely the milk from all cows which have reacted to tuberculin. The observations of C. Bolle, Schlunghaus, and Schroeder showed, that of seventy-five cows who reacted to tuberculin, only one gave milk, which produced tuberculosis when injected into a guinea-pig, so that the tuberculin test is considerably too severe. In cases of doubt the test may be employed, but in general a regular observation of milch cows and bacteriological examination of the milk at certain intervals will be sufficient. The methods of obtaining and dealing with the milk and the way it is supplied in large towns require more careful attention than they have hitherto received. Central dairies should be established, with special arrangements for the chemical and bacteriological examination of the milk, and facilities for cooling and centrifugalizing it. The milk should only be sent out in sealed vessels, with the name of the producer visible on the label; also frequent and unexpected visits should be paid to the dairy. All these precautions should be the subject of regulations, such as the town of Hamburg has already passed. Great care must also be taken that in handling the milk it is not infected with human bacilli. Till we reach this stage, the only remedy is to boil the milk before it is used. It is an evil, since in the boiling certain changes take place in the milk which render it less digestible, but it is the lesser one, as the bacilli are thereby killed, if not rendered entirely harmless to children.

Of great importance is the separation of tubercular adults from children, and tubercular children from healthy ones in the home and the school. It should be a matter of course that tubercular persons should not prepare meals, wash infants or their clothes, kiss children, be in close personal contact with them, and above all must not share a bedroom with them. But how often are these rules broken by tubercular mothers, sisters, or domestics? Besides the educative work of the tubercular dispensaries, and addresses given to mothers, sick and maternity nurses, and

Public-law doctors, there still remains much to be done. It is most necessary, as tubercular infection during the first year of life is nearly always fatal.

Efforts must further be made to remove healthy children from infected families, to strengthen weakly children in holiday homes, and to place children suspected of scrofula or early tuberculosis in healthy country places, or in forest and seaside homes. The erection of more country homes for convalescent children is desirable, since such children are particularly liable to infection if they are left in unhealthy homes.

Lastly, the schools must be considered. According to post-mortem records about 75 per cent. of children of school age show tubercular changes; at least 50 per cent. of all school children are in towns infected with tuberculosis, while the percentage of manifest pulmonary tuberculosis among school children is very much lower; according to Grancher it is about 1 to 17 per cent. Therefore care must be taken, in view of the compulsory nature of school attendance and the length of time the child spends in the school, that it does not directly or indirectly tend to spread the disease. It is necessary to exclude till cured cases of open tuberculosis among the teachers, scholars, and school attendants. Although Schmidt's assertion, that tuberculosis of the lung and larynx has very much increased amongst teachers in the public schools, has not been confirmed, the necessity still remains of a careful superintendence of the teaching staff, the school buildings, and the habits of those using them.

Further the schools should take up more than hitherto the education of the public in hygienic questions and particularly with regard to anti-tubercular measures. The school doctor should carefully search out cases of lupus and other forms of tuberculosis, and also those suspected of the disease, for which a thorough co-operation with the teachers is desirable; and when necessary advice must be given to the parents and the school and municipal boards as to the requisite methods for the treatment and care of such children. It is also possible for the school successfully to oppose the ignorance of the cause of tuberculosis, to widen the knowledge of how the disease is spread, to awaken the desire for hygienic surroundings, to insist on cleanliness in the home as the foundation of all hygiene in the girls' classes, to instruct the girls in the proper management and care of the house, and above all to awaken in both sexes a desire for a healthy life.

If our young people are to be educated in this way, it is essential that the schools themselves should practically illustrate

the methods taken for the prophylaxis of tuberculosis. The site and construction of the school buildings should satisfy hygienic requirements, the cloak-rooms, &c., should be well arranged, the class-rooms frequently damp-cleaned to obviate dust, the light, air and temperature in the schoolroom should be regulated, the timetable should be so arranged that the bodily exercise of the children should not suffer, playgrounds must not be forgotten, school baths and school meals provided for poorer children, and finally the visits of the school doctor should be obligatory. These arrangements are still defective, especially in country districts and in the higher schools of towns; in the whole of Germany there are only 1,000 school doctors.

With regard to the prevention of tuberculosis the introduction of regular gymnastics and methodical breathing exercises in the open air between the hours of lessons is to be desired. In this way an increased power of resistance, both general and local, is produced, and at the same time many dangers of infection outside the school are avoided.

Another very important factor is the care and treatment of the teeth at the school age. Some of the general causes predisposing to tuberculosis (anæmia and digestive disturbances) are consequences of defective mastication. There can be no doubt that deficient mastication in childhood lowers the powers of resistance, especially to tuberculosis. On this account Kirchner demands that the children should be supervised by school dentists from the time of their entrance into school, and if they have not their own dentists that treatment should be provided. In larger towns dental clinics have been installed at the expense of the community. But even if this is provided for, the care of the teeth between the years of 2 and 6, before the school age begins, must not be forgotten.

Lastly we may here refer to a question of prophylactic and therapeutic nature which has lately been raised. The abnormalities of the upper thorax described by Freund and their importance in predisposing to tubercular disease at the apex of the lung have been already mentioned more than once. Klapp considered this stenosis from a developmental standpoint and drew from it conclusions important for prophylaxis and therapeutics. With the phylogenetic and autogenetic changes connected with the assumption of the upright position the primitive keel-shaped thorax of the four-legged animal has been converted into the existing secondary, broad, more barrel-shaped form. Besides the immobilization of the apices of the lung and the consequent stagnation in the blood-vessels and lymphatics the circulation

itself undergoes considerable changes from the adoption of the erect position, which affect unfavourably the blood supply to the apex of the lung. While Freund recommends the mobilization of the stenosis by means of rhinotomy of the first rib-cartilage, Klapp attempts to relieve the rigidity and constriction without an operation by means of the systematic crawling exercises devised by him, which in the treatment of vertebral scoliosis have already achieved remarkable results. There can be no doubt that the temporary exercise of going on all fours accompanied with methodical movements (crawling on the stomach) is considerably more effective than all the breathing exercises and passive movements. Further advantages of this method are that the upper part of the lung is rendered hyperemic, the whole respiratory musculature is strengthened, the thorax is gradually widened and the heart relieved by the fall of pressure in the horizontal position.

We consider that the crawling treatment under proper control of the technique has a very marked effect on the stenosis of the upper aperture of the thorax, especially if the chest is badly developed and deformed. To realize thoroughly the capabilities of this method one should see with one's own eyes in Klapp's Clinic how the stunted, deformed children of great towns, who have not merely the predisposition, but are mostly already infected with tuberculosis, undergo a powerful revolution of the whole organism. We wish, however, that the method should be chiefly used as a prophylactic measure in weakly children with a bad family history and with a paralytic, phibionid, rachitic or sciotic thorax, and consider that it should only be used therapeutically in cases of endothoracic glandular tuberculosis and the very earliest forms of pulmonary tuberculosis in children. The most suitable places for carrying it out are children's sanatoriums, where it should be controlled by the Röntgen rays and a lung specialist.

The number of deaths from tuberculosis, which in childhood exceeds those from all the so-called children's diseases, has not during the last thirty years so appreciably diminished in children as in adults.

Certainly clinical, experimental and epidemiological observations show that a slight tubercular infection during childhood gives immunity against a fresh infection. But this immunity is only relative, which fails against a severe reinfection. Therein lies the necessity of protecting children from severe family and house infections and of commencing the prevention of tuberculosis with quite the youngest children. The farther view sup-

ported by recent studies in immunity, that the prevention of tuberculosis must be essentially limited to the age of childhood, is still problematical. Certainly there is some truth in v. Behring's dictum, that consumption in adolescents and adults "should be the keynote of the song to be sung to infants in their cradle." But there is no necessity to adopt exclusively v. Behring's view of the prophylaxis of tuberculosis.

LIST OF AUTHORITIES.

For want of space it is impossible to name separately all the authors whose works have been consulted. It is more in keeping with the practical nature of this book to limit the references to the more important publications. For convenience these references have been divided according to chapters, and the list of authors arranged alphabetically.

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